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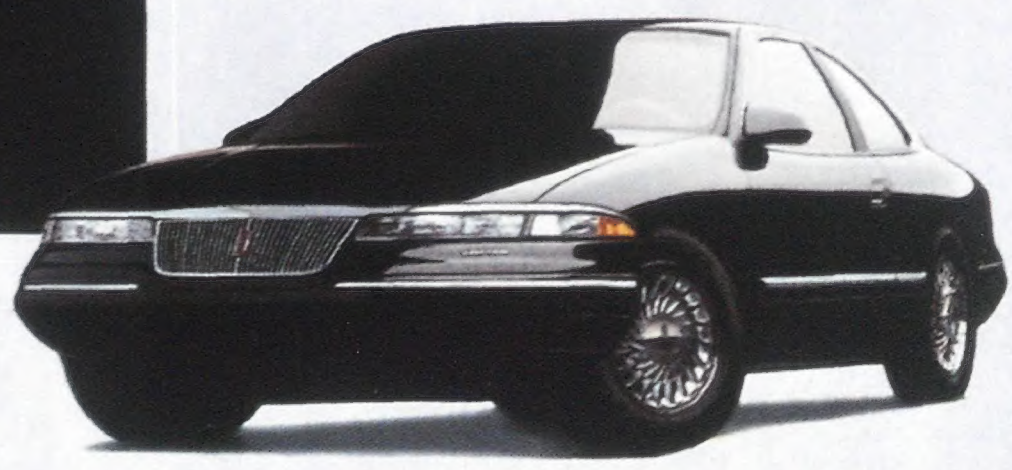

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April/May 1995
Volume 10, Number 1

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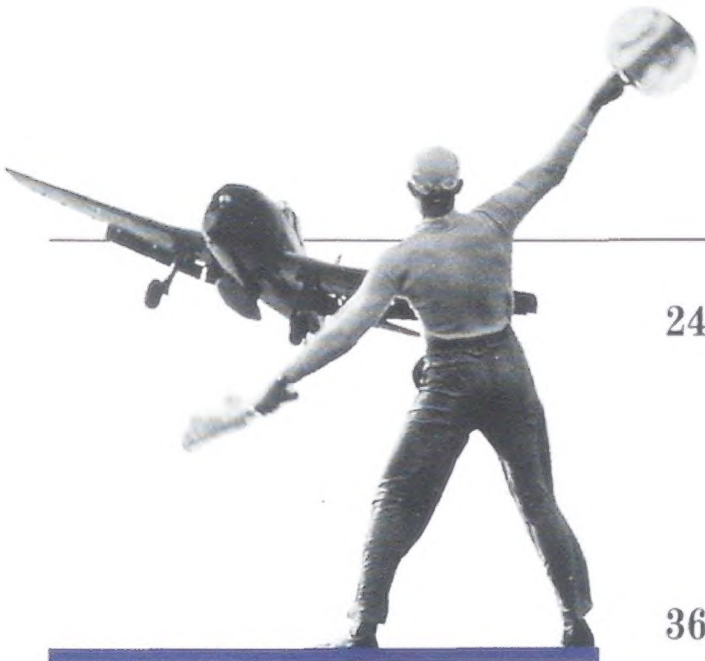

Special Graphic Supplement:

U.S.S. Abraham Lincoln

Explore a *Nimitz*-class supercarrier in this cutaway view.

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Cover:
A catapult officer on the U.S.S. Abraham Lincoln *directs an A-6 bomber to the number one catapult in this photograph by Chad Slattery.*

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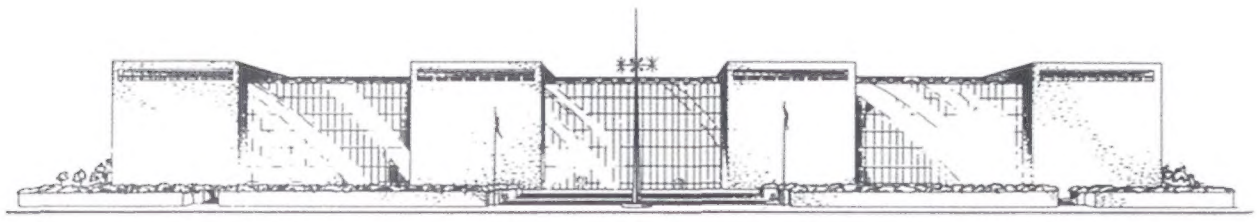

Rural Delivery

As we become used to seeing ever more industries benefiting from going into space, we might begin to wonder whether anything at all can be done better down here on Earth.

Navigation by means of the Global Positioning System is one recent addition to our space capabilities. It has begun to revolutionize air transportation and promises to make the use of air lanes far more efficient. Surveillance from space, for weather forecasting and ecological purposes, is another beneficial activity.

But other commercial endeavors in space may prove to be limited. In the search to grow perfect crystals, for instance, we still don't know whether space or terrestrial laboratories will ultimately prove to be more cost-effective.

Communication satellites already have been a revolutionary success. And several corporations are vying to launch entire networks of these satellites into space. But the long-term question is whether these satellites will ever become the primary data links for all communication needs or whether they are more likely to provide more specialized, "rural delivery" service.

Communication satellites have been spectacular in transmitting television programs across the globe so we can watch the Olympic games in real time or witness an armed uprising in a remote country. They also are great for providing links to sparsely populated regions and ships at sea. But are they likely to be a match for fiber optic cables, wherever those can be installed inexpensively?

One limitation is Earth's atmosphere. Only radio waves provide reliable transmission of information from space; all other wavelengths can be blocked by clouds. But the drawback with radio waves is that their relatively low frequency is incapable of transmitting information at a rate faster than a few billion bits per second. In comparison, fiber optics ultimately will be able to move data—bank statements, telephone calls, television programs, or any other data stream—many thousands of times faster. The glass fibers used for these links operate at infrared/optical frequencies, which permit the encoding and transmission of information at extremely high rates. And if additional communication capacity is required, it may be more economical to lay another cable, rather than launching another whole satellite network. Satellite data links could compete only if they were to transmit at the same short wavelengths and not be thwarted by clouds.

So why do we launch all those communication satellites? Partly to reach remote locations where access through telephone or fiber optic cable links is difficult. But as the industrial world expands and cable links improve, ground-to-ground communication via satellite is more likely to be the exception than the rule. Its main application may lie in delivery to locations remote from normal cable networks and mobile units—trucks, cars, aircraft, or ships.

Satellite transmission from space to ground, for the foreseeable future, will rely on radio propagation, slow as that data link may be. Ultimately ways may be found for satellite networks to transmit to the ground in other wavelengths wherever clear patches of sky are found, or by laser-drilling transmission holes through clouds. But these alternatives may never become viable.

Practical considerations may dictate a return to commercial links that once seemed doomed—in this case, ground-based cable nets. Other outmoded technologies already appear to be making comebacks, in a new guise. Solar arrays and windmills, for instance, may once again become viable sources of power, brought back by previously unpredictable technological advances.

As commercial applications evolve, some may become less competitive in space, while others find a new niche there. It's a challenging interplay—and difficult to predict.

—Martin Harwit is the director of the National Air and Space Museum.

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LETTERS

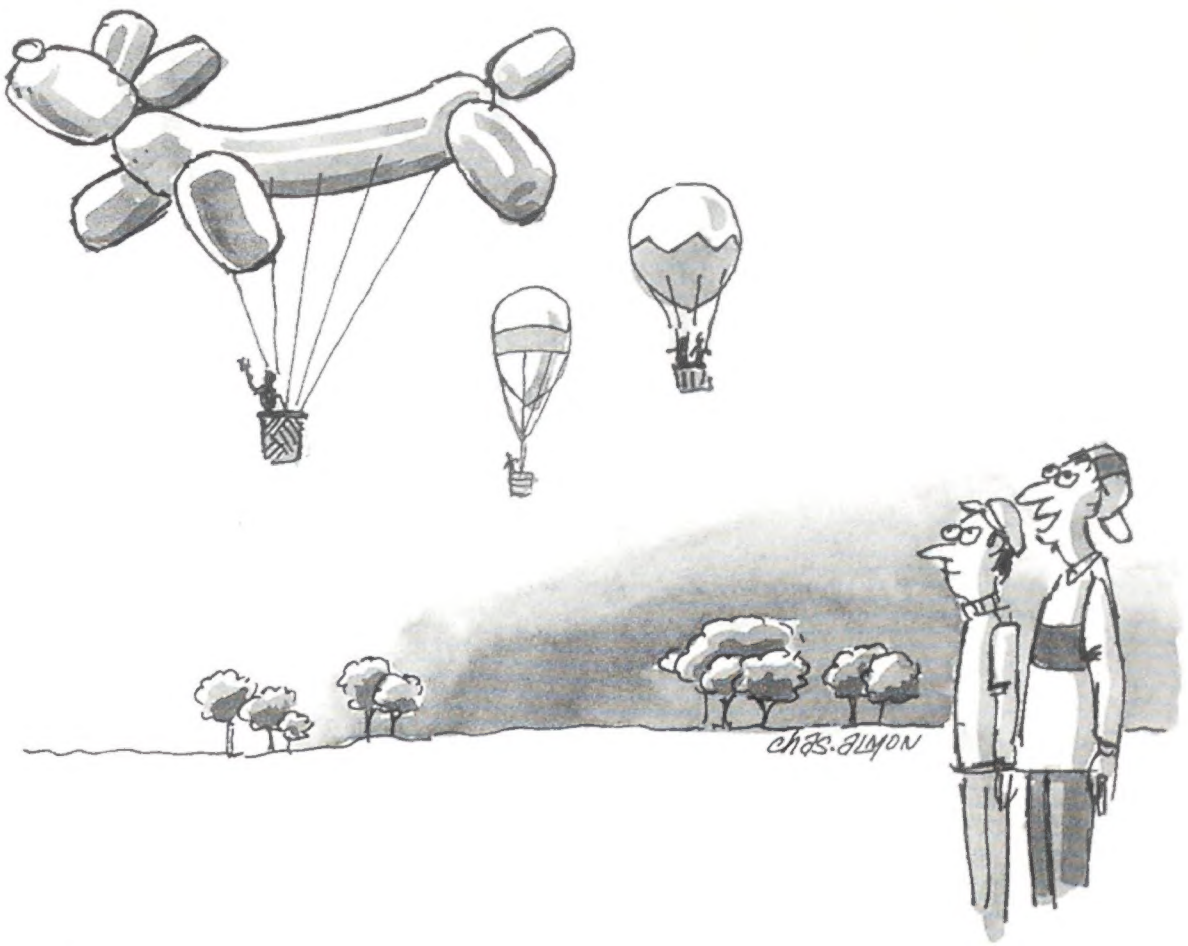
Hubble Rebuttal

In "Six Ways Back to NASA Greatness" (Commentary, Feb./Mar. 1995), Eric Chaisson uses the history of the Hubble Space Telescope to illustrate what he perceives to be NASA's lapses in scientific integrity and the technical inaccuracies in its press activities. As NASA's HST program scientist for over 16 years I want to point out several serious errors in Mr. Chaisson's commentary.

Referring to a press conference in which I had to tell the world how science would be affected by the mirror flaw discovered shortly after launch, Mr. Chaisson quotes me as saying "no real science can be done with its cameras." This is blatantly false. The videotape of that conference demonstrates that what I did state was that the Wide Field and Planetary Camera would not be able to accomplish its science but that the Faint Object Camera might be able to do as much as 30 percent of its scientific program. Moreover, every statement I made on that very painful day was a direct representation of the scientific assessments given to me by the very builders of the HST's six scientific instruments. James Westphal of the California Institute of Technology and Duccio Macchetto of the European Space Agency will verify the technical truth of my comments.

On the other hand, Mr. Chaisson also accuses NASA of hyping all our missions. If that is true, how does he explain the fact that I did not "spin" these initial negative assessments into something positive?

Mr. Chaisson goes on to accuse a NASA "lead scientist" of falsely stating that the HST's remarkable observation of a super-massive black hole in galaxy M87 was "totally unexpected." It's true that many of us fully expected this discovery, as Mr. Chaisson says, but the videotape of



"Harry not only graduated from flight school, he also went to Clown College."

that press conference shows that the scientist Mr. Chaisson quotes was not talking about the black hole itself but a rapidly rotating disk of ionized gas surrounding it. That *was* quite a surprise.

Finally, if we at NASA are the incompetents and bureaucrats that Mr. Chaisson paints us to be, how in the world did we ever manage to fix the HST—a mission many experts felt was the agency's most challenging since the Apollo moon landings?

—Edward J. Weiler
NASA Headquarters
Washington, D.C.

Eric Chaisson replies: Mr. Weiler's post-launch statement was actually: "No real science can be done with the telescope's main camera." But that statement is still an exaggeration—precisely the kind that misled the world into thinking that the Hubble was a piece of orbiting junk.

The Hubble's discovery of a gas disk in M87 was wonderful science, a neat confirmation of a theoretical model, but it too was essentially what I and every other astronomer I know had expected the Hubble to see.

Astronomers everywhere welcome the news that the Hubble's capabilities have been improved. And all Americans take pride in the astronauts who performed so well and so bravely in repairing it. In truth, though, the Hubble is no more totally "fixed" now than it was "broken" before.

"You have to admire that kind of tenacity."

Lines of Inquiry

"The Secret Weapon" (Feb./Mar. 1995) was fascinating. In the upper photo on page 81, there are four dashed lines. What do they represent?

—David H. Kirkpatrick
Rochester, New York

Editors' reply: A photo interpreter added the lines to show the target of that bombing run: the railroad yards at Coblenz, Germany, which were hit on September 19, 1944.

The Freewing: Too Good to Be True?

"Spratt, Schmittle, and Freewing" (Dec. 1994/Jan. 1995) does not mention the Pou du Ciel, a 1930s design that also had a pivot wing and turned out to be a killer.

—Norman N. Rubin
Silver Spring, Maryland

Editors' reply: The Pou du Ciel ("louse of the sky" or "flying flea"), designed by French flying enthusiast Henri Mignet, was a tiny single-seat craft with a pivot wing in front and a smaller fixed wing in the rear. The pivot wing was connected to the control column by four cables, and by pulling on them, the pilot could raise or lower the wing to alter the angle of attack.

Though the Pou was popular among amateur pilots in France and Britain in the 1930s, it was involved in a number of crashes. Wind tunnel tests conducted by the French Air Ministry showed that in a shallow nose-down attitude, the Pou tended to dive uncontrollably. Mignet devised several fixes, but the public lost faith in the airplane.

Ed Regis failed to illuminate exactly what trade-offs might be necessary in designing a freewing. Had he created a theoretical freewing design that was identical to a current or recent production aircraft in payload capacity, cruising speed, construction materials, and certification criteria, he could have determined exactly what impact the freewing would have on weight, power requirements, fuel consumption, and operating costs. That comparison would have demonstrated whether aircraft design has indeed been all wrong for nearly a century.

—Harper B. Atherton
Arlington, Virginia

Ed Regis responds: The aeronautical engineers at Freewing have done exactly that kind of comparison. In the case of a commuter aircraft such as the Aerospatiale ATR-72, for example, they claim that a freewing design offers reduced sensitivity to turbulence and therefore reduced torsional loads on the wing and reduced gust loads on the airframe. This enables the use of a lighter wing and airframe, which translates into reduced power requirements, lower initial production cost, greater range for the same payload, and lower fuel consumption and other recurring operating costs. Those benefits, together with reduced airframe degradation over time, extend the freewing craft's life span beyond that of fixed-wing aircraft of the same category.

Weighty Matters

"Heavens on Earth" (Feb./Mar. 1995) contains one phrase that perpetuates a mistaken notion held by most of the public and even a majority of engineers and scientists. I refer to the passage stating that the shuttle is "held in an arc that parallels the curvature of the planet by a balance between the force of gravity and the centrifugal force due to the curvature of the orbit."

The shuttle is held in an arc by gravity alone. That force causes the spacecraft to travel in what is essentially a continuous free fall toward Earth's center. If both gravity and a balancing force were acting on the shuttle, it would travel a straight line, not a curved orbit.

—Donald E. Overs
Library, Pennsylvania

Ferreting Out the Truth

In "Beyond the Iron Curtain" (Aug./Sept. 1994), William E. Burrows repeats the excuse the Soviets gave for shooting down Korean Air Lines flight 007: that they had mistaken the airliner for an RC-135 that made routine reconnaissance

flights in the area. However, I understand that at the time of the attack, the RC-135 had already passed through—in the opposite direction—and landed in Alaska. Furthermore, a transcript of the Soviet fighter pilots' radio transmissions as they searched for and shot down 007 showed that they did not care in the least whether their target was civilian or military.

—James L. Brewer
Grant, Alabama

Aerial Alliances and Misalliances

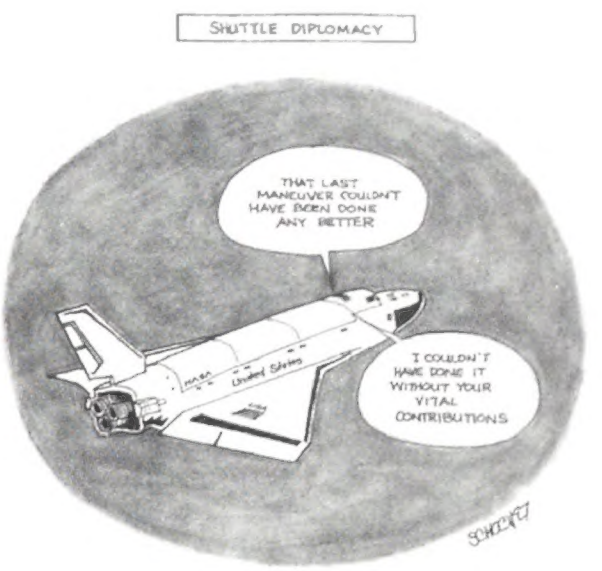
In "The Skies, the Limits" (Oct./Nov. 1994), Henry Scammell writes of the Russians' non-participation in the 1944 International Civil Aviation Conference, reporting: "[They] got about halfway to Chicago before turning back without explanation." According to a report by Eduard Amstutz, a Swiss delegate at the conference, "The Russians declared with some publicity that they would only participate under the condition that Spain and Switzerland would be excluded." I believe the Russians turned back because the U.S. refused to meet their demands.

—Captain Alfred Muser
Swissair (ret.)
Bachenbuelach, Switzerland

I disagree with L. Welch Pogue, who is quoted in "The Skies, the Limits" as saying that it is "unpatriotic and ridiculous" that our government permits foreign carriers to acquire part ownership of U.S. carriers. In my opinion, all that matters is that the system works.

Last Christmas, I booked a flight for my family from Geneva, Switzerland, to Columbus, Ohio, via Amsterdam and Detroit. Because of the excellent cooperation between KLM and Northwest Airlines, a trip that used to take us 22 hours took only 14.

—Randall F. Volpe
Vaud, Switzerland



Wernher von Braun's Ugly Past

I must disagree with one significant point in Alex Roland's review of Michael J. Neufeld's book *The Rocket and the Reich: Peenemünde and the Coming of the Ballistic Missile Era* (Feb./Mar. 1995; note the book's full title, which the review didn't include). Roland states that "no smoking gun directly links [Wernher] von Braun to the slave labor program" of Nazi Germany. However, Neufeld, using primary documents in German archives, established that von Braun, together with his superior, General Walter Dornberger, and his production manager, Arthur Rudolf, attended a meeting on May 6, 1944, "in which the enslavement of more prisoners was discussed." And on August 15, 1944, von Braun wrote to the director of the rocket factory that he had gone to the Buchenwald concentration camp "to seek more qualified detainees"—a Nazi euphemism for slave laborers.

—Robert Huddleston
Mercersburg, Pennsylvania

Corrections

Feb./Mar. 1995 "The Race to Save Rwanda": The photo on pp. 46-47 shows an Ilyushin Il-76, not an Antonov An-124.

"North American's Salad Days" (Soundings): The quotes attributed to Ed Horkey should have been attributed to Al Blackburn.

"Something Old, Something New": (1) Though Gene Oshrin started work on his replica eight years ago, he has put only about a year's work into it. (We also regret misspelling Mr. Oshrin's name.) (2) The P-12 was an Army fighter.

"Sightings": Pompano Beach is in Florida, not California.

Dec. 1994/Jan. 1995 "The Great War in Alabama" (Soundings): The Le Rhône engines powering the airplanes that flew in Alabama were originals, not replicas.

"The Papa Bear advocated the Hot Dark Matter theory; the Mama Bear advocated the Cold Dark Matter theory, but the Baby Bear advocated the Just Right Dark Matter theory."

Do You Speak the Language of Saturn?

The National Air and Space Museum is overseeing the restoration of a Saturn V rocket with an S-IC-T first stage, an S-II second stage, and an S-IVB-500F third stage. Anyone who can provide helpful information should write to Frank Winter, Curator of Rocketry, National Air and Space Museum, Smithsonian Institution, MRC 311, Washington, DC 20560.

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After the Dust Settles

Last January 19, test pilot Karl-Heinz Lang's X-31 went out of control at 22,000 feet during a routine flight over California's Mojave Desert. The X-31, part of a U.S.-German program to probe highly maneuverable combat capability using thrust vectoring (see "Stall Tactics," Apr./May 1991), was destroyed, but Lang was able to eject, landing relatively unscathed about two miles south of the wreckage. An anonymous source at Edwards Air Force Base writes of the scene:

"The woman operating the long-range optics camera—essentially a big telescope—had more reason for concern than anyone but the pilot," he says. "She tracked the pilotless aircraft from the point of ejection to the point of impact, becoming increasingly concerned as she realized the aircraft was heading straight for her house, near the Edwards north access road—and her daughter was home. Fortunately, the aircraft eventually impacted a quarter-mile east of her house.

"Water-cooler scuttlebutt quickly provided an official cause for the mishap: 'The aircraft had attempted to continue flight without the presence of the pilot, who had departed prior to the completion of said flight.' We probably should have given this statement to the local media. It would have made more sense than some of the accounts they printed.

"The pilot, who had completed his test card and was returning to base, noticed

ROCKWELL INTERNATIONAL

TONY LANDIS/DRYDEN

Martin-Baker

When Karl-Heinz Lang ejected from the stricken X-31, he joined an exclusive group of test pilots called the Martin-Baker Tie Club. The 6,500 members—half of them American—sport lovely silk ties (the three women members wear winged silver brooches) courtesy of the British company that designs and manufactures ejection seats. The Tie Club's numbers are growing at a steady peacetime rate of two or three punchouts a week, since the only requirement for membership is that you ride a Martin-Baker ejection seat and live to tell the tale.

Well, maybe not the *only* requirement: no Iraqis were awarded ties during the Gulf war. "They disqualified themselves," says Martin-Baker marketing head Brian Miller, speaking with the disdain of a good Brit guarding the oaken door of an exclusive London preserve. "But we did

erroneous airspeed indications and uncommanded pitch oscillations, which led to the aircraft becoming uncontrollable. At that point, he chose, quite understandably, to punch out.

"One TV anchorwoman indignantly reported that firemen attempting to extinguish the impact blaze had been turned away by base officials due to the highly secret nature of the aircraft. What actually happened was that NASA and Air Force hazardous materials teams already on the scene explained to the firemen that the X-31 carried both gaseous breathing oxygen and hydrazine to run its emergency power unit, whereupon the Kern County Fire Department lost all interest in fighting *any* fire in the vicinity of what sounded suspiciously like rocket fuel.

"Immediately after the impact, NASA secured the area to keep rubberneckers away from the hazardous materials and also to prevent them from prospecting for souvenirs. Access was limited to people with a clear official reason to be there. One of the first requests for an exception came from the base's industrial safety office. An employee demanded to determine if the X-31 had 'disturbed or damaged any endangered species or their habitats.' "

A NASA safety board is investigating the crash.

—Stephan Wilkinson

give ties to the Argentinians we shot down in the Falklands war. In fact, the first question one of their pilots asked when he met the guy who shot him down was 'How do I apply for a tie?' "

Martin-Baker issues its members a handsome silk cravat crafted by Gieves of Bond Street. The design is tiny replicas of the universal red DANGER EJECTION SEAT cockpit warning triangle blazoned on a field of blue. Also issued is a membership card that Gieves will demand if a member wishes to replace his tie. Some members already own backup cravats: four have ejected four times, 60 have scored three ties, and several hundred own two.

Martin-Baker didn't invent the ejection seat, but it is by far the world's largest rocket chair manufacturer, with 67,000 produced and an estimated 28,000 still in service (see "Chariots of Fire," Apr./May 1989).The high usage is a good index of the danger inherent in the kind of aircraft—mostly single- and two-seat combat and training jets—that come equipped with what the Brits call "bang seats": one out of every 10 Martin-Bakers will at some point in its lifetime be put to the test.

—Stephan Wilkinson

Ghost in the Machine

PAUL SALMON

To hear the fliers tell it, the military transport with tail number 7771 has been making mischief since 1969. That's when the Lockheed C-130 finished a duty tour in Southeast Asia and landed at Little Rock Air Force Base in Arkansas. After 25 years there, the airplane—nicknamed Spooky and fabled to be haunted by the ghost of a loadmaster who was killed in Vietnam—arrived at Patrick Air Force Base in Florida last June.

Members of Patrick's 71st Rescue Squadron, who use Spooky as a training aircraft, have a campfire's worth of tall tales about the Hercules. Back in Little Rock, Master Sergeant Dave Massey encountered the "ghost" as he worked alone in the airplane one night on a dark and deserted corner of the airfield. As the story goes, the onboard power died, leaving Massey, with no flashlight, to stumble to the cockpit. Out of the blackness came a voice mumbling a question. Massey's order to speak up was met with silence. In the cockpit, he discovered that the power unit had been switched off. And Master Sergeant Daniel Wassom told of once seeing a slender white light, as tall as an average man, moving about inside the airplane near the crew entry door. Suddenly the door area lights came on. The eerie thing was that Spooky's battery was dead. Another Little Rock sergeant claimed that on a rotation to England, the aircraft twice shrugged off heavy chains that he had used to tie it down when a storm approached.

Last August, according to the base newspaper *The Missileer*, Spooky toyed with four Patrick airmen who were flying home from a training mission in Virginia. The paper explained that when the navigation system and autopilot are coupled, the aircraft follows a programmed flight route. Two separate keyboard entries are required to alter the flight plan. The crew swore they hadn't touched the keys, but Spooky made a wrong turn and headed out to sea.

The Patrick public affairs office reportedly has received calls from anonymous individuals who claim they have heard footsteps on Spooky's wings. "There are some people on the flightline who will not work on this plane at night," wrote a *Missileer* reporter.

My six-hour flight aboard Spooky was uneventful, save for a flashing green light (in a fixture that holds only red and white bulbs) and a hair-raising yaw when a novice navigator advised the pilots to "hold it nice and steady" while he practiced celestial navigation.

Not everyone is willing to believe that Spooky is haunted by an airman's ghost. "It's a 1963 airplane and it has 1963 airplane quirks," says Captain Ken Dorsey, a Squadron 71 commander. However, Dorsey acknowledges that Spooky has had its share of mysterious electrical problems. Captain Randy Turner has a different take on the situation. "It's just a good airplane with a permanent crew member," he says.

—Beth Dickey

UPDATE

New Home for a Hellcat

The Navy has agreed to loan the Grumman F6F-5 Hellcat retrieved from the Atlantic Ocean last December to the Quonset Air Museum in Rhode Island (Soundings, Aug./Sept. 1994). Museum workers recently retrieved the aircraft's engine and other parts that were left behind during the museum's initial salvage and its ensuing battle with the Navy over ownership.

That Old Black Magic

With little publicity announcing it, Doug Nelson, curator of Palmdale, California's Blackbird Airpark, thought the 30th anniversary celebration of the first SR-71 Blackbird flight was going to be a bust. Then he found 300 people lined up at the gate for the December 18 event. "There's a kind of grapevine among these Blackbird aficionados," Nelson says. "They don't have to read it anywhere, they just find out."

Drawn by both the warm weather and the opportunity to meet SR-71 pilots, more than 1,500 visitors turned out for the celebration. "It's understandable," says Robert Gilliland, who made the first flight of the reconnaissance craft. "This thing was produced in the 1960s and it's still the highest and fastest plane on the planet."

On the maiden flight, Gilliland took off from Palmdale on December 22, 1964, and flew at subsonic speeds until he was about 200 miles north. He then accelerated to Mach 1.5 and climbed to 50,000 feet. On the return to Palmdale, famed Lockheed designer Kelly Johnson ordered a low-level flyby. "There was fuel streaming out of the bottom of the plane," says Gilliland. "Some general nudged him and said, 'What's *that*?' I think Kelly regretted that flyby."

The airpark features an SR-71; the first A-12, a CIA-operated version; and a D-21 drone version borrowed from NASA for the anniversary. Guests waited in line to have photos and posters autographed by Gilliland and other pilots, including Jim Eastham, who was the first to fly the YF-12A; Fitz Fulton, who flew SR-71As for NASA; William Park, who made the first flight of an M-21 mothership mated with a D-21; and former Lockheed Skunk Works pilot Tom Pugh.

Among those in line was John Battey, who estimates he has spent more than $5,000 on Blackbird photos and information since he first saw the airplane in 1980. "It's kind of a contest between me and my brothers as to who can get the best memorabilia," Battey says. "I have four notebooks filled with photographs signed by pilots, and pictures signed by everybody who was anybody with the Blackbird program."

With Lockheed starting restoration on three SR-71s under a $100 million allocation, there is renewed excitement among the aircraft's enthusiasts. "Now that they are talking about bringing them back," Nelson says, "people are going bonkers."

—Jim Skeen

UPDATE

Finding a Needle With a Haystack

During the shuttle *Discovery*'s flight last February, several tiny pieces of metal were released into near-Earth orbit in an effort to fine-tune the tracking of orbital debris ("Eyes on the Sky," Apr./May 1987) by the Haystack Long-Range Imaging Radar in Massachusetts. The Haystack LRIR and other radars and telescopes will base their calibrations on three spheres as small as two inches in diameter and three needle-size dipoles, five inches long and as thin as piano wire. Though this adds to the debris threatening satellites and space shuttles, a spokesman for Lincoln Laboratory, which manages the LRIR, says, "It's a trade-off. The value of knowing what you have outweighs the insignificant addition of small test objects that will reenter the atmosphere over the next few months."

Crash Course

The lights went out. Smoke filled the cabin. Jet engines shrieked. "Brace yourself!" someone shouted. Explosions went off and the sound of metal grinding on metal filled the cabin. Objects from the overhead bins flew through the air. "Release your seat belts! Get up! Get out!"

I leapt to my feet, bumping into my seat mate. Too many people in the way. The smoke grew thicker. I reeled toward the nearest exit, hoping it was clear. Finally I stumbled free. Others stood nearby, congratulating one another. Had this been a real airplane crash, would I still be alive?

Linda Pearson, president of SafeAir Services, hopes the answer is yes. Pearson, a former flight attendant and training supervisor for Braniff, coaches people to survive airline crashes. In her offices near Dallas-Fort Worth Airport, Pearson conducts seminars for corporations and individuals. Her classroom includes a mockup DC-8 fuselage and an emergency evacuation slide. The walls are covered with poster-size photos of crashed aircraft, battered and burning, but ones from which at least some passengers walked away. However, Pearson reluctantly concludes, "If your plane crashes into the side of a mountain, nobody walks away."

Passive behavior kills people as much as the impact. Pearson describes an American Airlines DC-10 aborted takeoff from San Juan, Puerto Rico, in 1978, in which passengers in the first class cabin saw the whole thing happen on the aircraft's video system, which was monitoring the takeoff. After the airplane shuddered to a halt in the water, the passengers, in what Pearson describes as a classic case of denial, remained in their seats. "Unless you hear the word 'evacuate' repeatedly, it often doesn't sink

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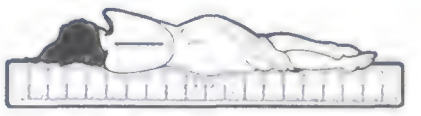

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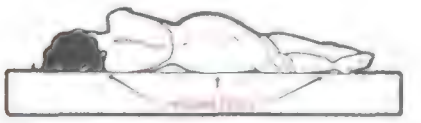

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in what you're supposed to do," she says.

During the seminar, we practiced sliding down the evacuation slide and took notes on Pearson's major tips: Women should not wear skirts, high heels, or scarves—"You need mobility and flexibility to escape," she says. Wear natural fibers, not polyester; synthetic materials melt in severe heat. Leather tie-on shoes beat athletic shoes, which can also melt. Locate exits upon boarding and count how many rows separate them from your seat—you may need to find them in the dark or in smoke. Before impact, loosen your necktie, remove jewelry, tighten your seat belt, and brace yourself by leaning as far forward as space permits, arms on the seatback in front of you, face between arms. "The lower you are," Pearson advises, "the more protected you are from flying debris." If forced to evacuate, leave everything and go. Don't carry anything that will delay your exit.

I boarded a flight to Portland, Oregon, better prepared, although somewhat nervous about the behavior of my fellow travelers. I watched them cram overhead compartments with luggage. Pearson had taught me how that luggage could land on our heads in a crash. G-forces can increase the weight of objects up to 16 times. A briefcase becomes an anvil.

When we fly, we show our faith in the statistics that say air travel remains safer than driving on highways. But airplanes occasionally crash. "When that does happen," says National Transportation Safety Board spokesperson Nora Marshall, "you can increase your chances of survival by being prepared."

—Hal Higdon

UPDATE

Boardroom Battle

Robert Iverson, a founder and CEO of Kiwi International Airlines ("Flier's Market," Oct./Nov. 1993), was fired last February due to the airline's crumbling finances. Kiwi's fortunes worsened when the airline suspended operations last December while settling discrepancies in pilot training record-keeping with the Federal Aviation Administration. Iverson, who is threatening a court battle, says that if he does not regain his position at Kiwi, he may start a competing airline.

CHAD SLATTERY

Last December a 1945 Northrop N9M-B Flying Wing, which underwent a 12-year restoration by volunteers at the Chino, California Planes of Fame Museum, made its first public flight for an SRO crowd. Four one-third-scale wooden N9M-Bs, with twin piston engines and 60-foot wingspans, were built in the 1940s as part of the Air Force's B-35 and B-49 flying wing program, which was canceled in 1949. The concept was resurrected 40 years later in the form of the Northrop B-2 bomber.

This Evening's Programming

Robert Newcomb, a Hanover, New Hampshire composer and computer engineer, found an unusual ally in his efforts to develop an original system of computer-assisted music composition: AutoClass, the NASA research software used to classify celestial anomalies found in data from sky surveys.

In 1992 Newcomb read about AutoClass in *NASA Tech Briefs* and realized it could be suited to his own purposes. He got in touch with the developers at NASA's Ames Research Center in California and volunteered to test the software. "I took some of the design concepts," he says, "bent and tweaked them for over a year, and finally was able to adapt them into a unique technology for making music."

The composer's goal in using the software isn't to write music that mimics a specific composer but rather to investigate the basics of compositional structure. "Robert is attempting to identify the brain patterns and thought processes that create music, and mimic them applying artificial intelligence," says William Burwell, program manager at the Center for Technology Commercialization in Westborough, Massachusetts, one of six NASA regional technology transfer centers. "Many times companies can't see what NASA could possibly do for them, and [with AutoClass] there was zero on the surface for the average person. But here's someone who was creative enough, without any assistance from us, to make it the backbone of his business."

In 1994, "Daydreams of an Orange Cat," the first composition fully realized by Newcomb's system, was presented at computer music conferences in the United States, England, and Brazil. The piece, given voice by keyboard controllers and electronic synthesizers, drifts and floats delicately for six minutes and 15 seconds, while the title cat dreams.

Newcomb says his goal is "to have a real-time input of data provided by movement—of people, of the stars, of anything—and have a piece of music being written as an intelligent response to that."

—Richard Sassaman

UPDATE

Departure

Ben Rich, head of Lockheed's Skunk Works for 16 years ("How the Skunk Works Works," Apr./May 1994), died of cancer last January at his home in Ventura, California at age 69. His recent autobiography, *Skunk Works: A Personal Memoir of My Years at Lockheed*, covers his 40-year career on the cutting edge of aircraft technology.

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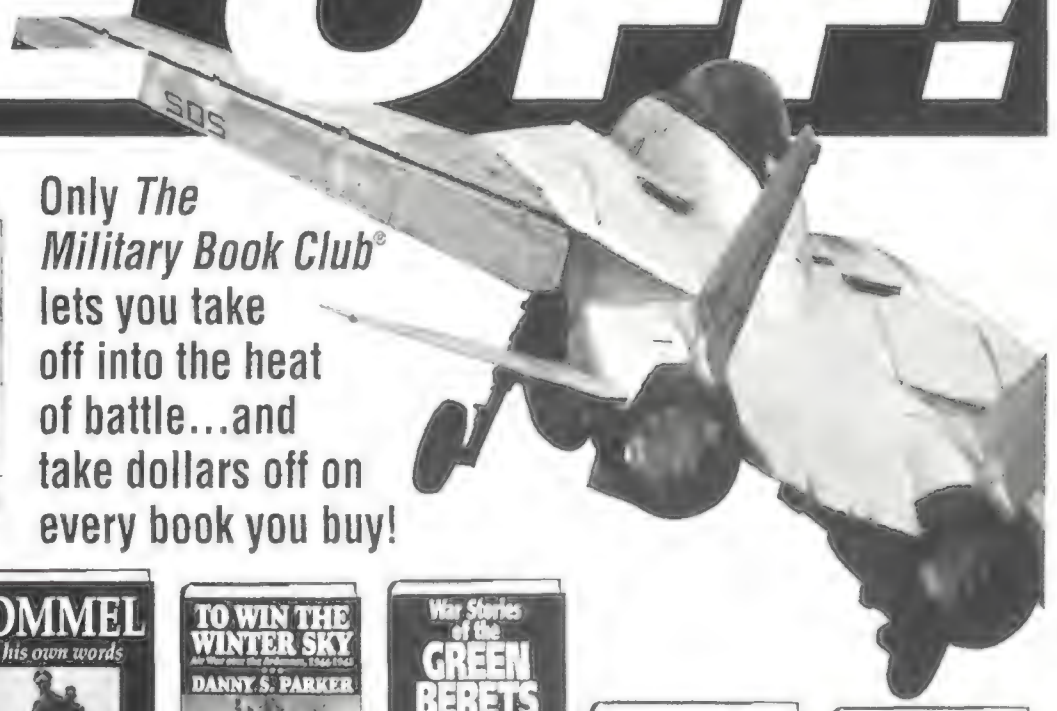

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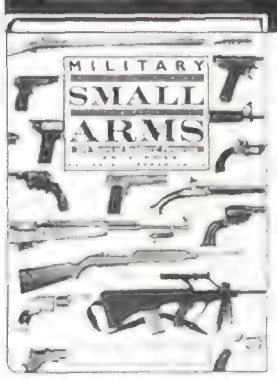

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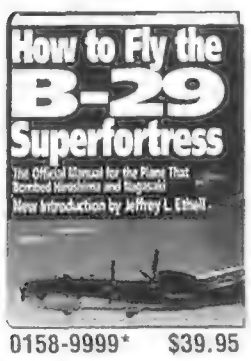

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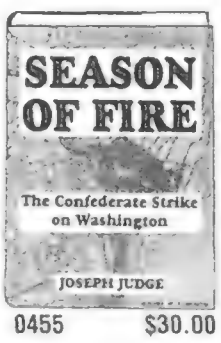

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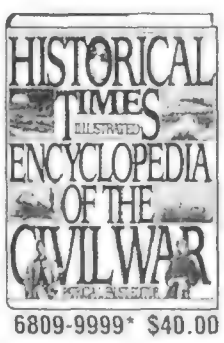

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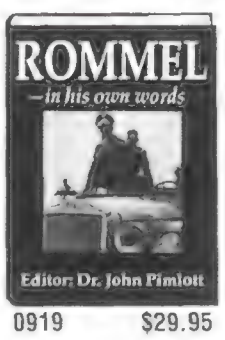

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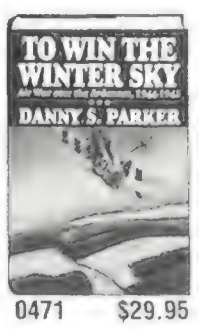

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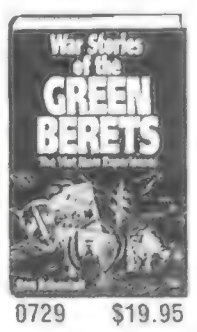

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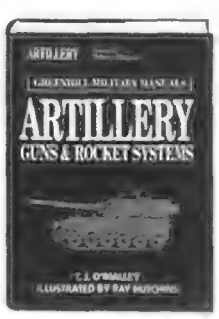

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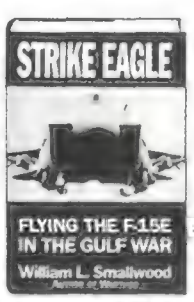

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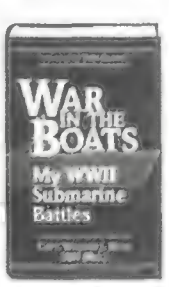

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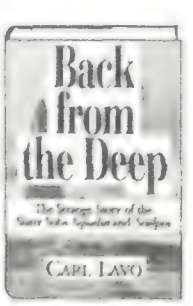

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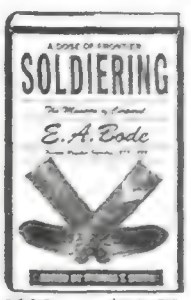

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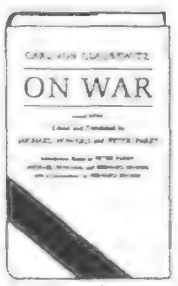

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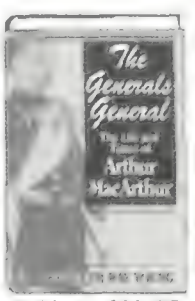

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Falling Blossoms

For American sailors stationed in the Pacific during World War II, there was no fate more terrifying than being the target of a Japanese suicide pilot, or kamikaze. Once a pilot had chosen a particular vessel, there was little its sailors could do to defend themselves. Explosions, fire, smoke, shrapnel—all marked the destruction and chaos that resulted from a kamikaze hit.

But it wasn't just fear that the Navy men experienced. Watching the kamikaze pilots fly to their deaths, they also felt shock and disbelief. In *The Divine Wind*, a 1958 book about the kamikaze missions, Vice Admiral C.R. Brown wrote: "I doubt if there is anyone who can depict with complete clarity our mixed emotions as we watched a man about to die. There was a hypnotic fascination to a sight so alien to our Western philosophy. We watched each plunging kamikaze with the detached horror of one witnessing a terrible spectacle rather than as the intended victim. We forgot self for the moment as we groped hopelessly for the thoughts of that other man up there."

Japan's Imperial Navy began mounting kamikaze flights in October 1944 to try to hold its position in the Philippines. Standard military aircraft, most commonly the Mitsubishi Zero, were fitted with bombs and sent on their one-way missions. But by 1945, as the war moved closer to Japan's home islands, the Imperial Navy had introduced the Ohka, a small missile-shaped aircraft designed solely for suicide missions. Equipped with an explosive charge in its nose, the Ohka—which means "cherry blossom"—was built to be nothing more than a manned bomb.

In February, a team of technicians at the National Air and Space Museum's Garber facility in Suitland, Maryland, completed a 10-month restoration of a Kugisho MX7Y Ohka Type 22 suicide bomber that was captured by the U.S. Navy in 1945. Rich Horigan, a senior preservation specialist, oversaw the restoration of the aircraft, which will go on display at the Garber facility.

Rich Horigan (above) oversaw the restoration of an Ohka suicide bomber that became part of the Smithsonian's collection in 1948 (below).

NASM

MARK AVINO

Compared to some of the other projects he has worked on—the Wright *Flyer*, a World War I German Albatros, a German V-2 missile, and the Bell XP-59A—the Ohka was a fairly simple undertaking. It was in pretty good shape when the Smithsonian acquired it from the U.S. Navy in 1948, and aside from halting some corrosion on the aluminum fuselage, the biggest job was restoring the 22-foot-long Ohka's original configuration. For some unknown reason, the Navy had modified the jet-powered Ohka Type 22 to look like a rocket-powered Ohka Type 11 by removing its two air intake scoops. So Horigan and his team fashioned a new set of scoops, using aluminum to match the construction of the originals.

The Ohka's fresh coat of pale green paint was mixed by members of Horigan's team to match the original color. But first they had to sand through layers of gray paint applied by the Navy and the Smithsonian. (The Navy had even taken the liberty of painting a rather attractive but inaccurate red trim on the Ohka's control surfaces.) Clues to the original color came when the aircraft was disassembled. "When you take things apart," says Horigan, "where the sun and water and dirt cannot get to, you have a very good definition of your [original] color."

Horigan, a pilot rated to fly both powered aircraft and sailplanes, says he would never want to fly the Ohka, but he

does admire its workmanship. "You'd think, since the person's going to fly it once and be killed, it would just be very crude and slapped together," he says, "but it isn't. From a design standpoint, it is very good." The canopy-covered cockpit, which is located just aft of the 13.5-foot wing, was built with the suicide pilot's comfort in mind: there is a real seat, which is positioned near a finely crafted stick for controlling the ailerons. And there are even air vents to regulate the cockpit's temperature.

The Museum's Ohka was never launched on a combat mission; in fact, none of the 50 Ohka Type 22s manufactured were ever operational. At war's end the Type 22 was still in development as a replacement for the rocket-powered Type 11. The Type 11s, which had a range of only 15 miles, were carried close to their targets by a mother aircraft—usually a Betty bomber—then released on a gliding trajectory. As the pilot closed in, he fired three solid-fuel rockets to increase his speed for the final dive. But it was an ineffective strategy: Allied fighters often shot down the mother aircraft before they had a chance to release their Ohkas. And even if the Ohkas separated successfully, they sometimes missed their targets and crashed into the sea. The Type 22, which would have carried a 1,326-pound bomb in its nose, was powered by a Tsu-11 jet engine mounted in the tail, boosting its range to 115 miles.

The Ohka was a weapon of desperation. By the time the Japanese navy began the program, the nation's position was dire. Its supply of ships and aircraft had been nearly wiped out, as were many of the factories that could have replaced them. With the threat of an American invasion looming ever larger, Japan's military leaders asked its young men to do the unthinkable, and initially, there was no shortage of volunteers. Known as Thunder Gods, the young pilots hoped that their suicide attacks would be enough to stop the American advancement (see "My Body Will Collapse Like a Falling Cherry Blossom," Apr./May 1991). But it was a hope misplaced. Although kamikaze attacks were responsible for sinking or damaging 215 Allied ships during the battle for Okinawa, Ohka Type 11s were responsible for only a small fraction of the hits, and the damage that they inflicted was more psychological than physical.

While working on the Ohka, Horigan took pains to preserve the aircraft's authenticity and duplicate its original appearance. He told his technicians not to paint over manufacturer's instructions and labels written in Japanese characters. And one of the final acts of restoring the aircraft was painting an outline of a cherry blossom on both sides of its nose. Like the fragile flowers for which they were named, Ohkas—and the young men who flew them—were never meant to last.

—Diane Tedeschi

Museum Calendar

Except where noted, no tickets or reservations are required. To find out more, call Smithsonian Information at (202) 357-2700 Mon.–Sat., 9 a.m.–4 p.m.; TTY: (202) 357-1729.

April 1 Monthly Sky Lecture. "The New Face of Venus." Data gathered by the Magellan space probe's four-year mission around Venus has revealed a far more geologically complex planet than scientists had previously envisioned. Jim Zimbelman, a geologist for the Museum's Center for Earth and Planetary Studies, discusses this new view of Earth's nearby planetary neighbor. Einstein Planetarium, 9:30 a.m.

April 12 Exploring Space Lecture. "The History of the Evolving Universe: A Journey to the Brink of Time and Space." Mauro Giavalisco of the Space Telescope Science Institute in Baltimore explains how astronomers using information gathered by the Hubble Space Telescope are beginning to reconstruct the evolution of the universe from the present back to a time only one billion years after the Big Bang. Einstein Planetarium, 7:30 p.m.

April 15 Family Star Watch. "Star Trek Fiction vs. Spaceflight Reality." Lillian Kozloski of the Museum's department of space history compares the design and function of fictional spaceflight garb with actual space shuttle clothing. Einstein Planetarium, 10:00 a.m.

April 20 G.E. Aviation Lecture. "The *Swoose*—It Flies?" Frank Kurtz recalls his career as pilot of the *Swoose*, the only surviving example of a Boeing B-17D. Langley Theater, 7:30 p.m.

May 11 Charles A. Lindbergh Memorial Lecture. Quentin Aanenson talks about his World War II experience as a P-47 Thunderbolt pilot with the 9th Air Force in Europe, as well as the creation of his critically acclaimed documentary, "A Fighter Pilot's Story," which aired on PBS. Langley Theater, 8:00 p.m.

Museum Visits For a free planning packet, write Smithsonian Information, Smithsonian Institution, Washington, DC 20560 or call (202) 357-2700. Daytime parking near the museums is limited; visitors are urged to use the Metrorail subway system.

ON THE ROAD

MARK PINKENSTAEDT

Last November, security was tight as the shrink-wrapped forward fuselage of the Enola Gay, *the B-29 that dropped the atomic bomb on Hiroshima, made its way down Independence Avenue en route to the National Air and Space Museum. After undergoing a 10-year restoration at the Museum's Garber facility in Suitland, Maryland, the 60-foot section moved out of its old home around midnight. The* Enola Gay *fuselage is the focus of an exhibit opening in May that marks the 50th anniversary of the end of World War II. (The fuselage was to have been part of a major exhibit titled "The Last Act: The Atomic Bomb and the End of World War II," which would have featured dozens of Japanese and American artifacts. On January 30, however, the Smithsonian announced that the exhibit would be reduced to the display of just the* Enola Gay *fuselage, along with a video about its crew.)*

THE MEN WHO

The Art of William S. Phillips. Dawn, the World Forever Changed.
Countersigned by Paul Tibbets, command pilot, "Enola Gay"; Thomas W. Ferebee, bombardier; Theodore J. Van Kirk, navigator; George R. Caron, tail gunner; and Richard H. Nelson, radio operator.

The Art of Craig Kodera. Lonely Flight to Destiny.
Countersigned by Charles D. Albury, pilot, "Bock's Car"; Fred J. Olivi, copilot; James F. Van Pelt Jr., navigator; John D. Kuharek, flight engineer; and Raymond C. Gallagher, assistant flight engineer.

A suite of two limited edition fine art prints accompanied by the video documentary "The Men Who Brought the Dawn."

1000 sets, each print signed by the respective artist, countersigned by the respective crew members, and numbered.

This video documentary will also be available separately at a later date.

After 50 years, the men who brought the dawn have been brought together to commemorate the events of August 6 and August 9, 1945—two days that profoundly altered the course of history in the first century of powered flight.

BROUGHT THE DAWN

Pictured above from the video documentary (left to right): Paul Tibbets, Fred J. Olivi, Richard H. Nelson, Charles D. Albury, George R. Caron, Raymond C. Gallagher, Thomas W. Ferebee, John D. Kuharek, James F. Van Pelt Jr., Theodore J. Van Kirk.

Through the memories of the men who were there, the stories behind the atomic flights of *Enola Gay* and *Bock's Car* have been uniquely documented for the future. In the fiftieth anniversary year of these climactic moments of World War II, those men, aircraft, and missions will take their places beside other famous fliers, aircraft, and events that The Greenwich Workshop has documented through the medium of the limited edition fine art aviation print.

To recount the great moments in aviation history is not only to portray the beauty and human drama of flight; it is to tell the story of The Greenwich Workshop. In more than a decade of pioneering aviation as a powerful subject for fine art and fine artists, The Greenwich Workshop has published a comprehensive collection of limited edition fine art aviation prints.

Our prints depict some of the most famous aircraft in history and have been signed by people who flew their ways into legend: General Jimmy Doolittle and the crews from the B-25s of the famous Tokyo raid . . . astronaut/artist Alan Bean and nineteen other astronauts from the Apollo lunar program . . . the "father" of strategic air power, General Curtis E. LeMay . . . three Medal of Honor recipients . . . the fliers who led the attack on Pearl Harbor . . . and many, many more whom we're proud to know as individuals and as friends.

At The Greenwich Workshop, we believe in the power of art to tell a story, especially when the artists include Alan Bean, Keith Ferris, Craig Kodera, William S. Phillips, and Frank Wootton, whose talent, knowledge, and inspiration have created a whole new arena for artistic expression.

Now, with the release of these limited edition prints commemorating the flights of *Enola Gay*, as depicted by William S. Phillips in *Dawn, the World Forever Changed*, and *Bock's Car*, as depicted by Craig Kodera in *Lonely Flight to Destiny*, The Greenwich Workshop renews it commitment to aviation art. And through the reunion of the men whose missions ended World War II, The Greenwich Workshop has created the only prints to bear the signatures of these ten men who were eyewitnesses to history.

As aviation flies into the twenty-first century, The Greenwich Workshop is adding twenty-first-century dimensions to its artistic documentation of flight. The unprecedented documentary film *The Men Who Brought the Dawn* is the first account, in their own words, by the men who flew the atomic missions. This documentary, currently in production, captures living history and human emotions, and offers rare archival footage of the events that brought the Second World War to a close. *The Men Who Brought the Dawn*, which is included as part of the suite of prints, will be available later this year.

For more information on the suite of prints and the video, please call (in the U.S.) 1-800-243-4246.

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Cleared for Landing

Can a crippled airplane be landed safely without using any flight controls? The answer started as a sketch on a TWA napkin. I was flying to St. Louis for a meeting with McDonnell Douglas Aerospace engineers in the summer of 1989 and was reading an account in *Aviation Week & Space Technology* of how United Airlines captain Al Haynes and his crew had recently managed to get their crippled DC-10 to the airport at Sioux City, Iowa, using only the throttles (see "I Can't Control the Airplane," *Air & Space*, Oct./Nov. 1991). Despite their heroic efforts, the airplane crashed on the runway, but over half of the occupants survived.

For the previous 10 years at NASA I'd been researching ways to make airplanes more efficient by integrating flight and propulsion control systems. We'd been using a research F-15 with a computer that looked at both control systems to improve performance. I immediately realized that by extending this research we could actually control the airplane with the engines—that is, the computer could help the crew control the engines accurately enough for a safe landing.

As I sketched this scheme for a propulsion-controlled airplane, or PCA, on the napkin, I mentioned my thoughts to my traveling companion, Jim Stewart, the F-15 project manager, and suggested that we try this on the F-15. He thought it was a great idea, and within five minutes we had outlined a test program. The next day we showed this idea to the McDonnell Douglas engineers, and they too thought it might work. We were both busy with other duties, so the PCA became our "between the cracks" task—worked on more during nights and weekends than during the workday.

One really nice thing about working where I do—at NASA's Dryden Flight Research Center at Edwards Air Force Base in California—is that it's a small outfit with a family-like atmosphere. We all know one another, and small things can get done with a minimum of formality and paperwork. I asked F-15 simulation engineer Tom Wolf if he could fix his simulator so I could try to fly it with the throttles alone. He called a day later and said it was ready to try. I found that by advancing one throttle and retarding the other, the F-15 rolled nicely, even though the engines are very close together. I also found that if I advanced both throttles slightly, the airplane climbed, and vice versa. This seemed quite encouraging, so I tried to land. I crashed the first several tries, but after some practice I did better. There seemed to be enough brute force control there that I felt that with a computer providing some finesse, safe landings would be possible.

I'm just a lightplane pilot, so I went to the NASA pilots' office in search of a real test pilot. I found Gordon Fullerton, veteran of two space shuttle flights, who had recently come to fly for Dryden. I asked if he could take a look at the F-15 simulation to see if he perceived the possibilities I did. He climbed in and agreed it seemed promising. But he also crashed on his first several landing attempts. While it was possible to keep enough control to maintain a rough altitude or heading without too much difficulty, the precise control required to land on a runway just was not there.

It was time to try the computer assist I'd sketched on the napkin. I asked Glenn Gilyard, a senior Dryden controls engineer, to put a simple control system together. Within a few days he had it working. The pilot used the control stick to make inputs and the computer took the stick commands, plus feedback from the airplane flight path and bank angles, and calculated the throttle positions. Glenn's PCA worked pretty well, and Gordon Fullerton and I both made nice landings in the F-15 simulator on our first tries. But we were no longer beginners. So we brought in Bill Dana, the NASA test pilot who flew the X-15 and was now the pilot for the F-15 project, and were gratified when he, using the PCA system, also made a perfect landing on the first try. At this point we thought we really might have something.

We tried throttles-only control on some airplanes and other simulators. Between Gordon and me, we flew a Learjet, T-39,

DENNIS TAYLOR

The no-frills PCA program got its start in an appropriately humble way: with the author's sketch on a napkin. DEFCS stands for Digital Electronic Flight Control System, a computer that integrates engine and flight controls; HIDEC stands for Highly Integrated Digital Electronic Control.

T-38, and a Piper PA-30, released the controls in flight, and succeeded in keeping the aircraft shiny side up. We tried approaches as low as 200 feet but did not attempt any landings. And we flew simulations of the Boeing 720, 727, and 747, McDonnell Douglas MD-11, and the piston-powered Cessna 402 light twin-engine airplane. In all cases we found a consistent story: the airplanes could be controlled well enough to maintain altitude within a few hundred feet and heading to within a few degrees, but not well enough to make safe landings consistently. The PCA system seemed to be necessary in all cases.

There were a lot of skeptics. A NASA manager said PCA was interesting but had no practical value. Another NASA manager, in Washington, told my boss that PCA was the dumbest idea he'd ever heard of and that we should stop working on it. My boss "forgot" to tell me this until several years later.

Jim Stewart invited pilot Al Haynes to come to Dryden to tell us the Sioux City story and to fly our PCA simulator. Haynes was impressed with what the computer assist could do. So were many other visitors.

Gordon liked the PCA system except for the use of a control stick. With its very slow, low-authority control, PCA has the feel of an autopilot, which normally is equipped with thumbwheels for making course adjustments. Gordon felt that since pilots associate the control stick with fast response systems, thumbwheels would be a better choice for the PCA. Tom Wolf had something working almost immediately. Gordon liked it, so we started a search for flight-quality thumbwheels. Our shoestring program did not have the funding for designing and building new ones, but our team member from the U.S. Air Force, Bob Yeager, found what we needed on an old F-4 at the Air Force Museum in Dayton, Ohio. He did the paperwork to get the panel removed and loaned to NASA for the PCA test. It worked perfectly.

In spite of the skeptics, we had no trouble getting Jim Stewart to agree to attempt to set up an actual flight test on the F-15. He went to the Air Force to solicit funding. At the briefing, one engineer asked if we were really planning to fly something that stupid. Luckily, another Air Force engineer, Terry Neighbor, was more farsighted and provided seed money for the first contractor PCA feasibility study. It looked good. As a result, Jim Stewart and McDonnell Douglas project manager Jim Urnes figured out a way to squeeze PCA into the ongoing F-15 research program.

Over the next year, McDonnell Douglas developed and tested the flight software. Some unexpected problems had to be sorted out. Normally, the F-15 is one of the nicest flying airplanes around. But to simulate a total hydraulic failure like the one Al Haynes and his crew had experienced, Gordon had to turn off the F-15's electronic and mechanical stabilization and then release the stick and rudder pedals. In this mode, the actual airplane proved to be much less stable than the simulation had indicated. The airplane was very hard to trim and would roll off one way or the other as soon as Gordon released the stick. It seemed that PCA would have to be very efficient to stabilize the F-15 so that we could adequately test the PCA software.

NASA

NASA pilot Gordon Fullerton climbs aboard a research F-15 on April 21, 1993, the day he first landed the airplane using only the PCA system.

By 1992 the PCA software was working well in the simulation and seemed ready to fly. In early 1993 the airplane became available. But the first PCA flight was disappointing. Roll control was very sluggish, and PCA did not handle turbulence well. Runway lineup was difficult. Performance was much worse than the simulator had shown. Fortunately, Ed Wells, the McDonnell Douglas PCA engineer, had made almost every part of the PCA software adjustable from the cockpit. With Gordon in the cockpit and Ed and me and the other engineers in the control room, we were able to converge on fixes for these problems in just a few flights. On April 21, 1993, Gordon landed the F-15 twice using the PCA system, without use of any of the flight controls. With Gordo working the museum-loaned thumbwheels, the idea sketched on a napkin had been proven to work.

We had six other pilots fly the PCA-equipped airplane, including one Navy and two Air Force pilots. All were impressed. After that, we decided to see how far we could go with PCA on the F-15. Although designed for low altitudes at Mach 0.3, PCA allowed us to fly to 38,000 feet and Mach 0.88. We also tried engaging PCA in unusual attitudes, as might be experienced after a major flight control failure. Gordon and the other pilots rolled the F-15 to a 90-degree bank and a 20-degree dive, released the flight controls, and turned on PCA. In every test, PCA recovered the airplane successfully.

So PCA works on the F-15. Where do we go from here? Some aircraft manufacturers have decided that a PCA system might be valuable in future airplanes, perhaps eliminating the need for a less capable hydraulics-dependent backup flight control system. Our next step is to install a PCA system on an MD-11, which we plan to flight test this fall. If the simulations are correct, PCA should work better on the big stable transports than it does on artificially stabilized fighters. But we know now that the simulations often don't tell the full story, at least not at first. We've tried the Sioux City scenario on an MD-11 PCA simulation, and pilots can make a safe landing on the first try. But will this prove true in the actual airplane?

We won't know until we fly the PCA system test on the MD-11. The F-15 had only one seat; I'm looking forward to riding along on the MD-11 to see what PCA control feels like. And for the long term? I hope to see PCA installed on some future design. And I hope it never has to be used.

—Bill Burcham

If They Could See Me Now

One glorious morning in 1945, when I was nine, our teachers at Yorktown Central School in suburban Westchester, New York, trooped all 300 of us out onto the grubby playground behind our single red-brick building. There we stood among the vicious iron jungle gyms and tooth-cracking swings—bewildered kindergartners, acne-plagued high schoolers, nose-picking fourth graders—with faces upturned like tiny flowers while a navy blue Grumman F6F cavorted above in the bright April sky.

I have no idea who the pilot was. An alumnus, I suppose, though it could have been a student's father or even a young ex-teacher gone to war. For all I know it was part of a recruiting drive, though what the Navy would want with hormonally challenged high schoolers I can't imagine. But I remember the Hellcat chuttering back and forth, almost certainly doing nothing more dramatic than a couple of enormous egg-shaped loops and a few rolls, its R-2800 engine barking out the surprisingly truck-like sound of a big, slow-turning Pratt & Whitney radial.

This was no Bob Hoover demo, with the belly nearly brushing the ground and polished wings flicking through precise eight-point rolls. This was just a new ensign with 2,000 horsepower in his left hand and the reins of a worn-out, slab-winged old steed in his right. I'm sure he was breaking every aerobatics-over-a-crowd rule the Federal Aviation Administration—which didn't yet exist—would someday come up with, but at least he was in a navy that let its pilots take their fighters home for the weekend if the trip could be logged as a training flight. Boy, did I want to be that ensign.

I never was. Decades later, all my flying involved civil airplanes, though some of them were fast and powerful enough to give me an entirely unjustified sense of pride. I remember one clear morning coasting down the approach toward Westchester County Airport in a Westwind business jet and looking out the cockpit window at that same Yorktown Heights playground, which from that altitude was a tiny rectangle with the old cinder track still circling it.

I couldn't help but think that down there somewhere were all the one-time football players who used to make fun of me. "Collie-face" was one of the appellations that mocked my bookish phiz. Another athlete whacked me on that playground in front of my very temporary girlfriend, Marilyn Mincher, who had briefly adopted me as a toy because we'd appeared together in the high school play. Tony Lombardi resented that mightily, for Marilyn was captain of the cheerleaders and he the obese center of our farmboy football team. (I even got thumped big-time by Myra Tompkins, a tough girl on the schoolbus. You can bet word of *that* got around fast.)

RICHARD THOMPSON

I hoped they were all beer-bellied 7-11 clerks and washed-out supermarket cashiers reduced to watching "Geraldo" reruns as their window on the world, and I wished they could see me whistling over their heads in the left seat of a shiny executive toy that had more digits in its price tag than a phone call to France. (Of course, I didn't own it.) But they'd never know, and the fantasy remained just that.

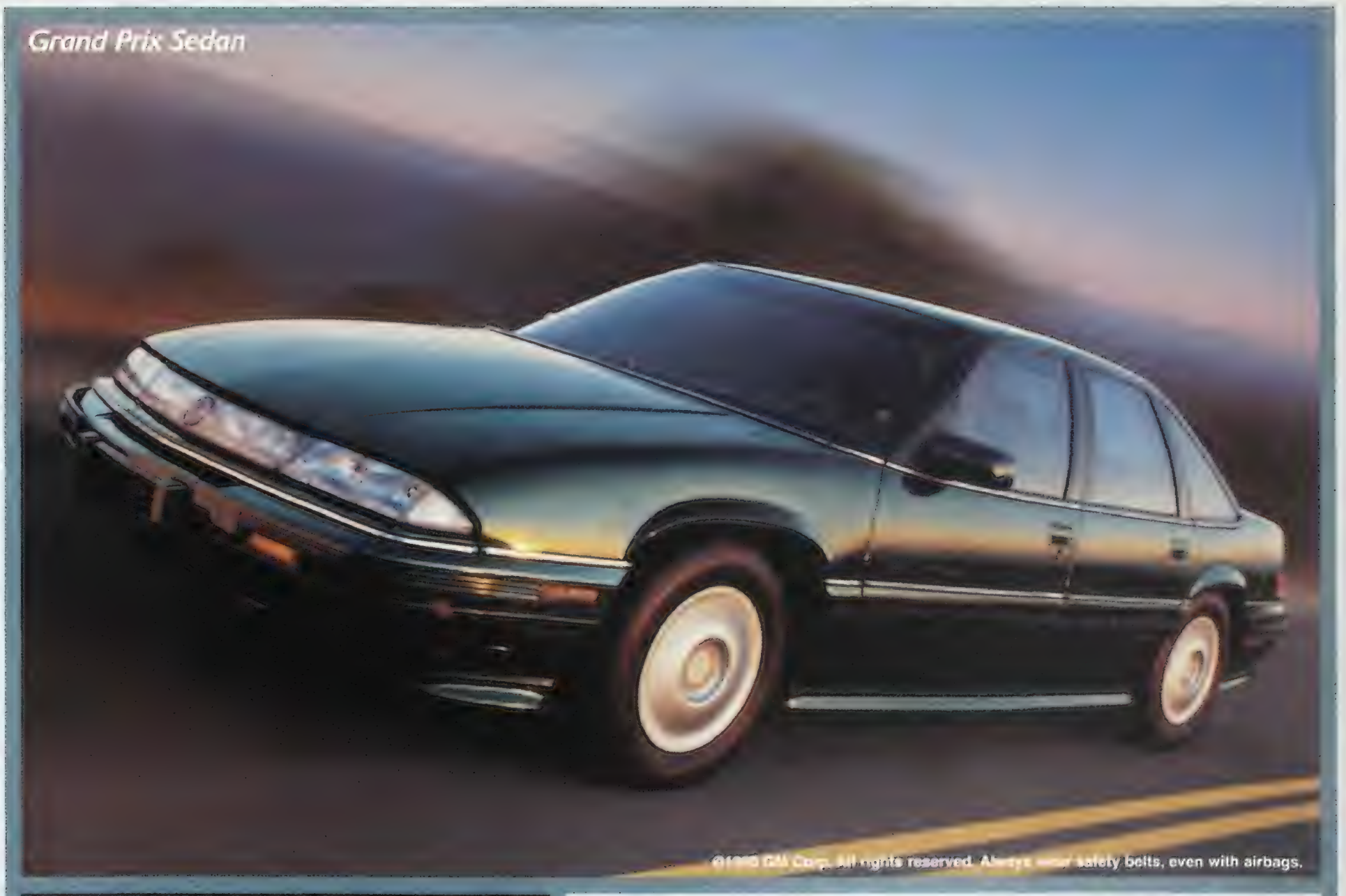
Until a few months ago. Don't tell the FAA, but I buzzed the 40th reunion of my prep school graduating class. My airplane rattled the windows of Trinity-Pawling School, forced a time-out in the big homecoming-weekend football game, and figured prominently in dinner-table conversation. This time, I made sure that Harris Lydon, the Class of '54's slickest dude, best drummer, and accomplished ladies' man, knew that I was coming.

So when the little red and gray mock P-51 came out of the sun—don't they always come out of the sun?—and swept the length of the gridiron, leaving behind it the Merlin-like whistle characteristic of a Falco F.8L flat-out at 220 mph, Hare-Babe was able to yell, "Do you know who that is up there? That's Wilkie! *Steve Wilkinson!*"

"I'll be damned," muttered my old Latin teacher, his spine curved from age. ("He can hardly look at anything but the ground anyway," Lydon later told me, "but he looked up that time.")

Why isn't he here at the reunion if he can fly over it? some of my classmates might have asked. But I'm not much of a reunion guy. As Iris Dement sings, "Let the mystery be." If all they know of me now is that brief shining moment when the fighter-like airplane I'd built with my own hands stood on a wingtip in the sun, with me looking down at all the faces upturned like tiny flowers, that's enough. It may not be every pilot's lifelong fantasy, but it certainly was mine.

—*Stephan Wilkinson*



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by Peter Garrison

Photographs by Chad Slattery

LORDS OF

The A-6E Intruder bomber thunders past the USS *Abraham Lincoln*'s starboard side and rolls into a nearly vertical left bank. Condensation flickers above its swept wings like white fire; its airspeed bleeds rapidly from 300 knots to 150 under the drag of the five-G turn. In the cockpit, the inflatable G-suit snaps tightly around Lieutenant Brian Kasperbauer's legs. His eyes dart from the dancing blur of black instruments to the horizon beyond.

Parallel to the aircraft carrier, Kasperbauer rolls level. *Check speed, dirty up with gear and flaps, double-check tailhook down.* Twice he lifts himself slightly from his seat, twisting, adjusting his posture and the feel of the seat pad on his thighs—the nervous gesture with which he habitually begins each pass at the boat.

On the landing signal officer's platform near the carrier's stern, the hook spotter examines the A-6 through binoculars. Meanwhile, an F/A-18 Hornet is on short final, a swift imperturbable projectile. Ropes of vapor stream from its wingtips like an illustrator's speedstrokes. It roars by the platform and traps, the LSOs genuflecting to see which wire it caught. "532, gear and hook down," calls the hook spotter, and the phone talker shouts "Foul deck!" Lieutenant James "Snapper" Knapp, the controlling LSO, turns to the bookwriter. "A little long in the groove," he shouts over the din of the deck. "Stopped rate

Landing signal officers originally used body language to guide pilots aboard carriers. Today's LSOs, using radiotelephones, are more subtle: for them and the fliers, it's all in the voice.

NASM

"Right for lineup…don't go low…a little power…."
At sea, the last word belongs to…

LANDING

of descent in the middle, a little high in close, OK 4-wire."

"532, Intruder, ball, 5.6," Kasperbauer radios, confirming his identity, his sighting of the glideslope indicator, and his fuel level.

"Roger ball."

The Intruder rolls out in the groove. Now the normal smoothness of flight is replaced by a series of sharp jolts. With small, swift control movements Kasperbauer—call sign "Ghost," both for the "Kasper" and for his prematurely gray hair—juggles the luminous amber ball on the port deck edge whose alignment with a row of green lights tells him he's on glidepath. The sound of the two turbojet engines continually jinks up and down. Fifteen seconds. The ship is large already; the landing area looks wider than long. The Hornet is just turning off the far end of the angled deck. No distraction! Meatball—lineup—angle of attack... Kasperbauer doesn't wait for the ball to tell him what to do, but nudges it just to the top edge of center, where he can best see it move. There he plays it, cat-and-mouse, mastering rather than following it, with swift firm motions of the stick. He's flying in expanded time: Fifteen seconds take as long as a minute of normal life.

"Foul deck!" calls the phone talker. "Foul deck!"

Snapper holds his arm aloft, a signal to the air boss, chief controller of flight operations, that he knows the deck is obstructed. He can hear the fluctuating engines of the Intruder as the gray blip, seemingly motionless in the sky half a mile away, slowly grows.

An F-14 pilot on the catapult prepares for the easy part: the cat shot off the carrier (below). Getting back on is more difficult, especially at night, when vertigo and illusion make the heart beat faster. At left, the trail of sparks indicate a "bolter": the hook misses all four wires and bounces down the deck.

"Clear deck! Gear set, 380, Intruder!" The arresting gear is set for the 38,000-pound aircraft; the deck is ready. Snapper lowers his arm and glances at the televised image from the deck centerline camera. He squeezes the press-to-talk button on the telephone handset he holds to his left ear.

"Right for lineup."

The quiet voice floats in the center of Ghost's head. A tiny correction; he had allowed himself to drift a few feet to the left of centerline. Five seconds to go. The most difficult seconds: he is nearing the narrow end of the funnel, where deviations in the path of the 19-ton jet are measured in inches. The deck is rising on a swell as he descends. He's at the ramp—the aft end of the flight deck is already behind him—he seems headed for a point far down the deck—a quick correction for lineup, wing down, wing up, just a few degrees in a split second—the deck is coming up—the headset voice soft but with a warning crescendo: "pow-WERRRR"—and the wheels squash onto the deck. He feels the blips as they roll over the three-wire and the four-wire, and as his left hand—*Trap!*—pushes thrust up to full power, the airplane slows and a massive force, gentle at first but building fast, drags his torso forward.

Snapper turns to the bookwriter. "Pitching deck. A little high all the way, a little lined up left in the middle, OK 3." The next jet, an F-14, is already in the groove.

Ghost and Snapper: their contact is brief, impersonal, almost wordless. Like dancers or athletes, they know each other intimately through the discipline of a shared expertise. Between them they achieve, with a reliability that makes them appear routine, things that are in fact nearly miraculous.

Flying jets onto an aircraft carrier requires, in addition to certain natural aptitudes, intense training and constant practice. The pilot must control speed, attitude, and position with microscopic vigilance. At the aft end of the flight deck—"at the ramp," in the carrier pilot's jargon—the window through which the arresting hook must pass to catch the target third wire is only two feet high. An airplane weighing 20 or 30 tons and spanning 20 yards must reach that narrow slot at precisely the right rate of descent and attitude. The hook dangling from the airplane's tail is supposed to clear the ramp by at least 10 feet; but the ramp itself, in heavy

LSOs are possessed of a keen eye, a quick mind, and a bookwriter who records their observations. A wry sense of pride in their work completes the package (top, left).

seas, may be rising and falling 15 feet and sashaying side to side in a figure-eight as well. And all the elements—speed, attitude, height—are linked. A change in one causes changes in the others. Carrier landings resemble those games in which you try to roll one ball bearing into its well without allowing others to roll out of theirs.

The lightest penalty for imprecision is humiliation. The gravest is sudden and violent death.

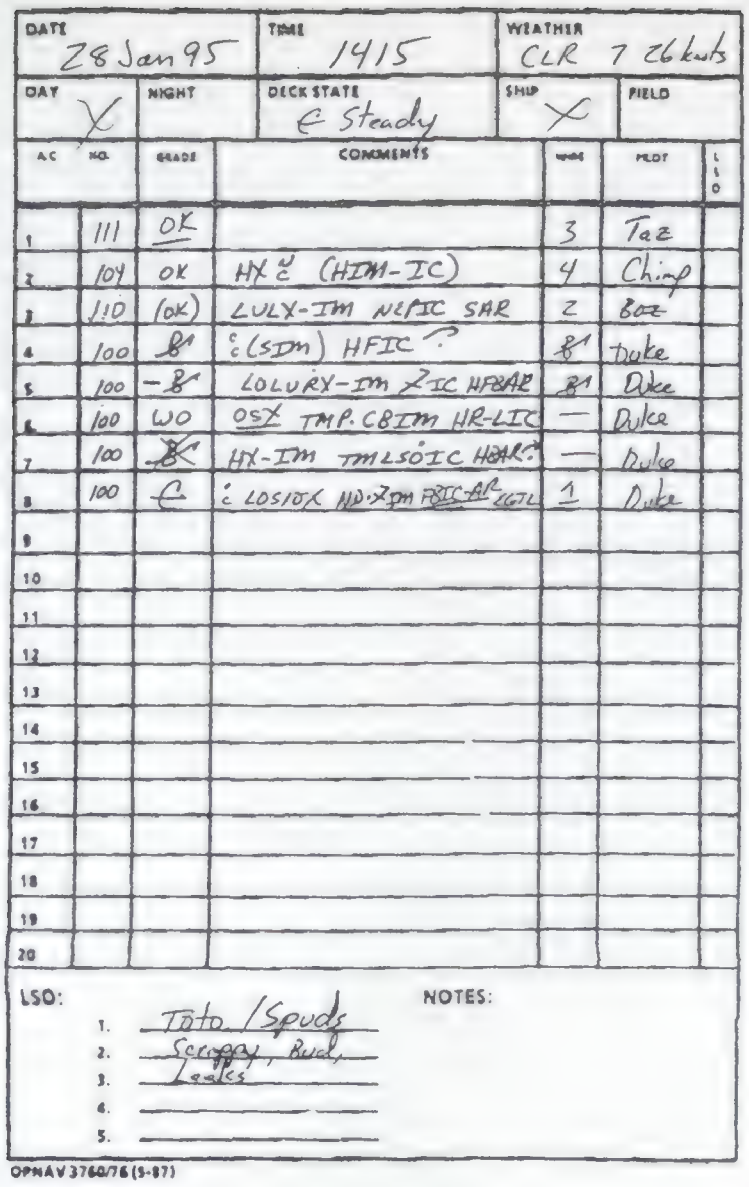
Technically difficult as they are, however, day landings in calm seas, once you've got the knack, are pure fun; Navy pilots would trap and shoot all day if they could. But night landings are different. Any night landing can turn into a struggle with vertigo, illusion, and terror. A pilot's heart can pound harder when he's making a night pass than it does when he's dodging surface-to-air missiles or dogfighting. Night allows no mistakes. It replaces the familiar and inviting deck—"where the food is"—with a shifting trapezoid of faint lights outlining a blacker hole punched in a black sea. The pilot hurls himself at that hole, trying not to flinch at the "deck rush" that floods his peripheral vision as he crosses the ramp and the blackness around him suddenly resolves itself into the carrier.

Commander Chris Nutter, a veteran of 700 traps and the executive officer of VFA-137, an F/A-18 squadron on the *Constellation*, tries to convey to non-pilot friends the sensations of the night landing: "Imagine that you're in a car without headlights going 150 miles an hour down a narrow dark road toward a one-car garage illuminated by a single light bulb. If you get through the garage door, your car will stop automatically. And the garage is moving around. That's what the night landing is like."

The pilot does not run this gauntlet alone. He has a partner, another pilot on the deck who watches him and guides him home: the quiet voice in the headset, the landing signal officer. Surprisingly, the LSO can judge the path of an approaching airplane, even in fog and darkness, better than the pilot can. This fact of carrier life came to light in 1922, when Kenneth Whiting, a commander aboard the *Langley*, the Navy's first carrier, grabbed the hats of two sailors and ran out onto the deck to wave them at a pilot making an ugly approach. The role that Whiting's impulse created quickly became an institution.

Today everyone calls the LSO "Paddles" and his job "waving," but the words are anachronistic. Until the 1950s, when the optical glideslope was introduced in the U.S. fleet, the LSO had stood at the stern, sometimes clad in fluorescent overalls, illuminated at night with ultraviolet light, waving two paddles like beribboned tennis rackets at the approaching airplanes. He was a human glideslope, signalling pilots right or left, higher or lower, faster or slower. His gestures were a mixture of semaphore and mimicry of the approaching airplane. Both arms up, for instance, meant "You're high, come down." When the airplane was in position to land safely, the LSO would lower his left arm and jackknife his right across his chest—the "cut" signal—and the pilot would chop the power and drop the nose slightly to put the airplane into the wires.

Much of the personal touch was lost with the introduction of the optical glideslope. In the old days LSOs tended to be conspicuous characters, often outlandishly dressed (or, in World War II in the Pacific, hardly dressed at all). One found his way into fiction: James Michener's big Texan, Beer Barrel, in *The Bridges at Toko-ri*. "Beer Barrel is my shepherd, I shall not crash," the pi-



DATE	TIME	WEATHER
28 Jan 95	1415	CLR 7 26 knots

DAY	NIGHT	DECK STATE	SHIP	FIELD
X		Steady	X	

	A/C NO.	GRADE	COMMENTS	WIRE	PILOT	LSO
1	111	OK		3	Taz	
2	104	OK	HX-IC (HIM-IC)	4	Chimp	
3	110	(OK)	LULX-IM NEPIC SAR	2	Boz	
4	100	8	(SIM) HFIC	8	Duke	
5	100	-8	LOLURY-IM 2IC HFBAR	8	Duke	
6	100	WO	OSX TMP. CBIM HR-LIC	—	Duke	
7	100	~~8~~	HX-IM TM LSOIC HBAR	—	Duke	
8	100	C	LOSIOX NO-XIM FBIC AR CCTL	1	Duke	
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LSO:
1. Toto / Spuds
2. Scrappy, Rud, Loules
3.
4.
5.

NOTES:

OPNAV 3760/76 (5-87)

APPROACH/LAURINDA MINKE

According to this sample LSO notebook, Duke had a tough time getting on board. Pilots know better than to argue with an LSO over a grade, so they vent their occasional frustrations in cartoon form.

Making the Grade

Besides the electronic aids—phones, radios, and lights—the LSO uses a unique shorthand to record each pilot's landing attempt, or pass, in his little green ledger. Later, at debriefing, the LSO thumbs through the pages for the grade he gave each pilot. The number of points after each annotation is part of the total that helps determine the ranking of squadron pilots at the end of a deployment.

1. Highest grade. Hook snagged the 3-wire, approach was perfect. (5 points)

2. Generally favorable pass. Started high; corrected nicely but remained slightly high from midpoint in the approach—a half mile behind the ship—to close to deck. (4 points)

3. Fair pass. Lined up left from the start of the approach through midpoint. Did not carry enough power in close to the deck, settled at the ramp. Landed short. (3 points)

4. Bolter. Did not catch a wire and had to go around. Overcontrolled a slight settle in the middle, then went high and fast close to the ramp. (2.5 points)

5. No-grade bolter resulting from a below average approach. Low, lined up right at the start. Dots indicate that the LSO called for power either over the radio or with the lights. Pilot flew up through the glideslope as he got closer to the ship and got faster and flatter at the ramp. Rate of descent slowed, aircraft began to float, flew over the cables. (2 points)

6. Waveoff. Grossly overshot the centerline at start of the approach, got too overloaded with corrections to come back to the centerline, ended up high right-to-left in close to the deck. (1 point)

7. No-count bolter. High start continued to the middle of the approach. LSO made a recommendation he regretted, like a call for power close in when it wasn't needed. Pilot responded to directions but ended up missing the wires with a bolter. LSO did not count the landing.

8. Unsafe attempt. Pilot overcontrolled a low, slow start, then pushed the nose down while flying up through the glidepath in the middle. Was extremely fast and flat in close to the deck and over the ramp. Eased off the power to land (major error). This is the worst grade an LSO can award; although it carries zero points, it is figured into the overall total as a try.

—Ken Skaggs

lots intone. Beer Barrel smuggles beer onto the ship in his golf bags. He waves drunk.

Beer Barrel is a caricature, but he embodies an insight into the relationship between pilots and LSOs. His alcoholism is a metaphor for the irrational and uncanny quality of his perceptions—his "zen." In fact, when the LSO was still waving paddles the job demanded a sort of unconsciousness. "There is not enough time to mentally analyze the situation and then give a signal," a World War II LSO wrote. "Most of the time you don't even know what signals you're giving." The pilots still sense that today. When you're flying at unyielding steel at 130 knots, trying to spear that tiny garage in the dark, you want the LSO to be more than a mere rational being. You want him to be a magician. You want him to be infallible.

Most LSOs are pilots, and most are junior officers; only a few—the carrier air group LSOs, of whom there are only two or three per ship—have many years in the job behind them. Most LSOs volunteer for the position; when there is a shortage of volunteers, a few are assigned to it because they seem to possess the right mix of flying skill and personality. The position is in many ways untempting. LSOs work long hours

exposed to cold, wind, and wet, often far into the night. The mess is closed by the time they finish. And the responsibility is greater than in any other job open to a junior officer. Finally—and for many pilots this is the key objection—LSOs generally get to fly less than their squadron mates do.

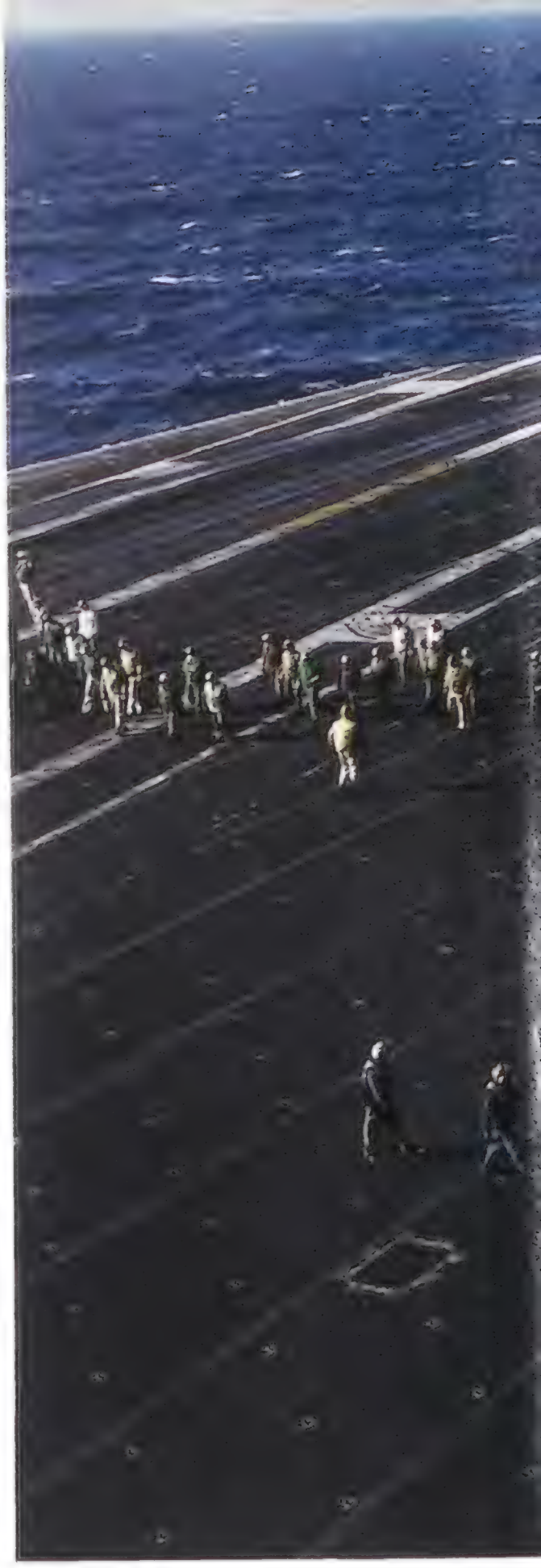
Those who do volunteer for the job are people who are attracted to rather than repelled by responsibility. The seriousness of it draws them, as does the opportunity to be a conspicuous and central figure on the ship, one of a small and elite fraternity. They like the "coolness" of the position, the visibility, and the fact that of all the anonymous and interchangeable myrmidons on a carrier, they are among the few who personally *matter*.

LSOs need to be above-average ball fliers themselves. Not that it makes any difference to their eye; non-pilots could be LSOs, and a few have been, especially during World War II, when LSOs were chronically in short supply. Retired Captain Monroe "Hawk" Smith, a former F-14 pilot and chief of staff of the naval air force's Atlantic fleet, puts it nicely: "You don't have to be a dog to judge a dog show." But it's really a matter of credibility. Pilots unhappy with their grades shouldn't be able to console themselves by thinking: *What does he know? He's never done it!*

Every LSO attends classes at the LSO school in Oceana, Virginia, at least once. It's run by Philadelphia-bred Lieutenant Commander Tom Quinn, a big man with a comic gift and an ear for aphorisms. "LSOs aren't gods," goes one of his favorites, "they just have god-like qualities." Each lecture begins with an off-color joke—obligatory in Navy schools—and between lectures the classroom TV runs tapes of mishaps: a deckhand being sucked into an A-6's engine inlet (he miraculously emerges, somewhat the worse for wear), a Tomcat hitting the ramp and exploding, an A-3 making a faulty barricade arrest that causes seven men to die. As a three-day class for veteran LSOs ends, Quinn, whose waving days are over, says, "I envy you so much, but I'm so glad I don't have to go on that platform again because I've seen things that would turn you white."

Most of a new LSO's training takes place not in school, however, but on the platform. He is sent up with a white flotation vest with "LSO" or "Paddles" stencilled on the back; he supplies his own dark glasses and, preferably, a funny-looking wool cap. He watches approaches...and watches approaches...and watches approaches. At first they all look alike. Then, like eyes slowly growing accustomed to darkness, his perceptions sharpen. He begins to see the tiny undulations of the airplane with respect to the horizon, even a horizon marked only by the single light on a destroyer swallowed in fog three-quarters of a mile away. He learns to listen for the power changes, the sibilant whine of turbojets and the hoot of the S-3 Viking's turbofan engines, and he measures their magnitude, frequency, and timeliness. His eye learns to gauge an airplane's speed and attitude by minute signs: the wedge of fin peeping above a wing that tells him the airplane is too flat, or the bit of sky between wing and stabilizer that says "nose too high."

He learns the infinite variations of the approach and the quirks of the airplanes and their pilots (although it's an adage of LSO impartiality, not always observed, that you wave the tailhook, not the pilot). He anticipates the influence of the winds on the "burble," the eddying of the air around the aft end of the carrier's tower, or island, through which pilots fly close to the ramp; the "moth effect" that draws pilots to the left, toward the ball, because they con-



The crew gets a chance to stroll and socialize during FOD walkdowns—scans for foreign objects that could be sucked into and damage an engine.

A net under the LSO platform is meant for use in emergencies, but it is handy in less dire circumstances as well.

centrate on it rather than the deck; the tendency to "settle on the ball call" at night, because pilots feel that they're too high when they come off instruments and first see the ball. And the quirks of the airplanes: the tendency of the A-6 and EA-6B to settle on lineup corrections; the F-14's slow power response and its susceptibility to hook-skip bolters (failure to trap because the hook bounces over the wires) when the pilot corrects for a slightly high approach: the S-3's vulnerability to the burble, especially with starboard winds; the critical importance of lineup for the big-span E-2C Hawkeyes.

Armed with an encyclopedia of miscellaneous knowledge, the LSO waves an increasing variety of aircraft under a widening range of conditions; eventually, most likely at the end of his second cruise as LSO, he earns the "wing qual" that permits him to wave every type of aircraft in the wing, day or night. By the time he earns his wing qual, he has seen thousands of passes. His memory is well stocked with worst nights. Carriers recover airplanes under unbelievable weather—on nights of fog, rain, or snow, with ceilings of 200 feet, visibilities of a quarter or half a mile, in which airplanes materialize at the stern only five or 10 seconds before they trap; and in seas on which the deck dances to a wild, syncopated tune. These are the nights when, after the recovery, the pilots sink into the tattered seats in the ready rooms with the deepest sense of shared relief, and for a change receive the LSO's visit with more affection than sarcasm.

The LSO platform is a small rectangle protruding from the port side of the ship by the first arresting cable, bathed by turns in the hot eye-smarting fumes of jets at full power and the deeply chilling ocean wind. It's tradi-

tionally been unfurnished, but that's changing: On the *Constellation*, a resourceful LSO managed to get approval for the addition of a bench using the novel argument that VIPs, who are frequently guests on the platform during carrier qualifications, might get tired of standing. A windbreak shields the platform, and two of its edges drop off into a net, where everybody is supposed to jump if an airplane hits the ramp. At the aft edge of the platform is a black box containing communication equipment, a TV screen that shows the image from the centerline camera buried in the flight deck, and devices for reporting the type, distance, and speed of the approaching aircraft, the speed and direction of the wind over the deck, and the magnitude of the ship's motions.

Attached to the console by a long cable is the "pickle," a black handle with two switches. One of them operates the waveoff lights: red lights flanking the meatball that tell the pilot to abandon the approach. The pickle switch is the LSO's last resort for keeping pilots off the ramp.

There's usually a small crowd on the platform. At the very least there will be two LSOs: the controlling LSO, who is junior, and the backup LSO, often a carrier air group LSO or team leader, who stands behind him. Other junior LSOs on their first cruise in the job may be present to gain experience. One of them may serve as bookwriter: he takes down the controlling LSO's comments about each pass in a small notebook. There are also two enlisted men: a hook spotter and a phone talker.

Their routine is simple and endlessly repeated. The LSOs hold the pickles overhead as the approaching airplane enters the "groove," the final three-quarter-mile of the pass. This is a signal to the air boss, high in the island, that they know that the deck is "foul," not ready to receive an airplane. When the deck goes clear, a red light on the deck edge turns green, one or two voices on the platform call out "Clear deck!" and the LSOs lower the pickles to their sides.

After the initial "Roger ball," the controlling LSO's communications with the pilot are usually sparse, but the more trouble the pilot is having, the more the LSO will talk to him. Early in the approach, his calls are informative or advisory; close to the ramp, they become imperative: The pilot must obey them immediately. The most imperative of all calls is "Waveoff!" Thus, the pilot's traditional final authority over his flight is shared, in a carrier approach, by the LSO.

After an airplane traps, the book writer records the LSO's comments—and, if the pass was "colorful," the LSOs exchange witty remarks about it—and the next airplane appears in the groove.

When he senses a pilot is having problems, the LSO starts with what they call "phone sex" or "sugar talk," a patter of brief encouraging remarks mixed with subtle guidance. A lot of talk—"liplocking the guy"—is discouraged; pilots can stop flying the airplane, just waiting for the next instruction from the LSO. But an even, sympathetic voice makes a great difference to an unnerved pilot.

Almost every pilot at one time or another has a problem getting aboard. He makes pass after pass, five or six of them, until everyone else in his sortie has landed. He goes to the tanker, which is the only other airplane still aloft. Then the carrier air group LSO comes on. He steadies the pilot with brief, calm remarks, and when the airplane is at the ramp he uses his "buffalo call." Each experienced LSO has his buffalo call, the utterance he uses to keep the pilot from flinching from the deck at the last moment. The phrase itself doesn't matter—it can be as simple as "Don't climb" or "Don't go any higher"—but there's an art in its use, a precise tone and timing that is part of the virtuosity of a good LSO, and it brings the pilot into the wires.

When the deck is pitching severely or if the optical glideslope is not working, the LSO calls for the MOVLAS—manually operated visual landing aid system. The MOVLAS is a surrogate for the meatball, in a way a throwback to the man-to-man days of the paddles. The LSO controls the airplane through a chain of command worthy of Rube Goldberg. He senses a deviation and moves the MOVLAS accordingly. The pilot sees the MOVLAS and adjusts as though it were the meatball, and the LSO feels—ideally—that by moving his hand on the MOVLAS controller he moved the airplane. The MOVLAS gives the LSO the ability to target any wire, and to anticipate the movements of the deck; he can also exaggerate his move-

Once on board, each aircraft folds its wings to maximize precious storage space (below). Moving aircraft around the flight deck to accommodate launches and recoveries is an endless game of musical chairs (right).

ments, so that deviations seem larger to the pilot than they are, if he wants the pilot to react more vigorously. The pilot becomes his robot, the approach almost a virtual reality game.

After all the aircraft in a sortie have trapped, the LSOs go down to the carrier air group LSO office, a tiny narrow gray room below decks near the platform. A couple of them confer over the pass book. "Wait, I've got two 301s. Was there a 201?" "Yeah, he came after the Hornet that boltered." One man hunches at the keyboard of a desktop computer, keying in the records of a previous recovery. Overhead in the corner, a movie airs on the TV. Conversation lags and attention turns to the screen as a woman emerges from a shower. "Hi honey, I'm home!" a young lieutenant cheerfully calls to her.

Then three of the LSOs are off to hunt the pilots down in the ready rooms, the parachute lofts, and the maintenance control rooms where they report gripes about the equipment. The LSOs are now no longer controllers but teachers, and their manner may be magisterial or comradely. The debriefing takes 30 seconds. There's a technique; they learn it at LSO school. Hold the grade book so the pilot can't see it. Never start the debriefing with "okay." Make eye contact. Speak clearly and firmly. Review the book with other LSOs before you talk to the pilots: Don't critique one pilot for another pilot's mistakes. If you have to fake it, at least know what wire the pilot caught, because the pilot will probably know that. Never undercut another LSO. Sense the receptive moment for advice. Preface criticism with a compliment. Don't vacillate. And never, no matter how much a pilot argues, change a grade.

Most pilots are attentive, nodding as the LSO reels off his description of the pass. They murmur thanks, or sometimes a gibe—"Where's your guide dog today, Paddles?"—or an explanation of a mistake, or a simple "Thanks for keepin' me off the ramp." Then the little knot of LSOs is striding off to a ready room at the other end of the ship.

Every pass gets a grade, roughly similar to those you got in grammar school. Apparently, somebody high up decided that too much praise is bad, so the best you can do is "OK." A perfect pass (preferably flown under adverse conditions—say, with an engine out) gets an OK underlined, to distinguish it from an unadorned OK, or, somewhat worse, an OK in parentheses which means "fair." If you mess up badly enough you get a "gash"—a diagonal slash through the little grade-box, meaning a below average pass, a D. At the bottom of the list is a cut, your school's F, meaning "gross deviations inside the waveoff window." The basic distinction is really between safe passes and unsafe passes; a cut is an unsafe pass.

GEORGE HALL/CHECK SIX

On final approach, a pilot keeps an eye on the optical landing system known as the meatball on the port side of the carrier (left). It's just one of the battery of electronic devices LSOs use to wave aviators aboard and grade their landings (above).

Squadrons record the grades on the "greenie board" in the ready room, so called because OK passes get green dots. At the end of the cruise the pilots with the best grades make the top 10 and get shoulder patches to sew onto their flightsuits. But grades are really just a spur to the pilots—highly competitive, Type A personalities, they will be quick to tell you. They bolster their competition with a steady traffic of bets whose common currency is alcohol. "Rat's last one was a fair. He owes me a Sam Adams." (Pay-ups must wait until shore leave or the end of deployment; alcohol is not allowed aboard U.S. Navy ships.)

The grades don't go beyond the ready room and the carrier air group LSO office, where they're added to a computer database that's used to spot trends.

LSOs don't get to fly as much as their peers, but playing a starring role in the ongoing drama of carrier aviation makes up for the loss.

Everyone knows that you can be a good pilot and not a top-notch ball flier, just as you can be a good basketball player with a low free-throw percentage. But if it weren't for the grades, just getting aboard would be enough, and a faultless pass to a three wire would be no different from a bumpy ride to a one or a four. Pilots would get lazy. They would cut the meatball some slack. Eventually, some would hit the ramp.

Most LSOs leave the job after three or four years. When they hang up their paddles they say goodbye to the icy wet nights on the platform, to the monotony of field carrier landing practice and the tension of night carrier qualifications, to the fear for the pilot who's on his fourth or fifth pass and still can't get aboard. Goodbye to the exhausting nights when each action, each word or omission of a word, each reaction or failure to react could mean a pilot's life.

They should be glad. But most of them retire from waving with regret. At the end of the worst nights—nights when terms like "comrade," "protector," or even "savior" did not adequately express the relationship of the LSO and his pilots—they trudged from the platform drained, but with a sense of relief and accomplishment that nothing else could match. They have played a starring role on that platform, and they know that nothing in their future is likely to equal it.

Mr. Goldin Goes

by Theresa M. Foley

NASA administrator Dan Goldin has a fantasy. He's standing in front of an audience in the NASA headquarters auditorium, a slide projector control in his hand. He clicks once, and on the large screen behind him flashes a photograph of a planet, a familiar bluish ball. Surrounding the ball, he tells the audience, is an imperceptible gauze of atmosphere containing oxygen, carbon dioxide, nitrogen, and water vapor. The image looks like any of the dozens of photographs taken of Earth from the moon during the Apollo program. But this photo is different, and Goldin is about to announce the nature of that difference. The ball is not Earth. "Holy smokes," says the administrator, brought back to the present by the need to share the excitement of that dream. "Could you imagine if we could find a terrestrial-like planet within 10 light-years of Earth? I contend we will get humans there within 50 or 100 years of that finding. That one picture could change the whole way we view ourselves on this planet," he says.

And he's off, spinning the dream, words rushing out to explain why the search for such a planet is so important, what it means about the nature of humankind, how the work NASA is doing now supports it, and how he'd like to be the one to put that picture up on a screen. The 55-year-old administrator sounds like a little boy—a kid from the Bronx—talking about where he could go if he could only build a spaceship. When he lays it out this way, NASA's mission becomes irresistible.

So why do so many people within the aerospace establishment resist this man?

"People are terrified," says one aerospace industry official. "The threat [of canceled projects] hangs over every contractor."

"What he's done to humans has been brutal," says another. "Lives and careers have been thrown out as if they were nothing."

I first met Dan Goldin in 1989. I had just been appointed editor of *Space News*, an aerospace trade newspaper, and I was in Los Angeles covering an annual industry symposium, which Goldin, then a TRW, Inc. executive, was chairing. During one of the breaks we ended up in the same small group of people discussing the perceived flaws of the space program, and he lit into me for the sins of the news media, which, he said, had cost this country the Vietnam war. It was an oddly personal attack, especially given the fact that I was barely out of grade school during Vietnam. So I know that Goldin's charm, so effective in presenting his vision for NASA and taking the space program to the people in town meetings, sometimes disappears.

The next time I saw Goldin he had just become the administrator of NASA, and his pugnacity was already becoming legendary in the clubby aerospace community. "When you are an agent of change, you cannot coddle those who are resisting change," he says. But Goldin's combative crusade for reform has made him a controversial figure. People both for and against him can only hope that when the crusade has ended, NASA will have something to show for it.

Goldin was brought in by the Bush administration in April 1992—and retained by the Clinton administration—to fix the country's broken space program. NASA had become such an embarrassment to the Bush presidency that more than a year earlier Vice President Dan Quayle held a secret meeting aboard Air Force 2 to decide how to force a change. In addition to making the president's announced plan to explore the moon and Mars look ridiculously out of reach, the agency had chalked up a long list of projects with huge cost overruns and lengthy delays. The long-awaited Hubble Space Telescope was flawed. The space shuttle was running into highly publicized technical troubles that regularly delayed launches. According to an administration source who was at the meeting, White House chief of staff John Sununu considered the agency such a mess that he asked Quayle and his advisors if they should get rid of NASA altogether. The meeting resulted in the decision to fire the NASA administrator, former astronaut Richard Truly, although it took another painful year before the president acted.

Goldin came to the attention of the administration in 1991 through a study conducted by one of his teams at TRW. The study suggested that small, relatively cheap satellites could replace the behemoths then proposed for NASA's Earth Observing System, a constellation of satellites to study the global environment. The small-satellite approach found backers on an EOS review panel convened by NASA, the White House science advisor, and the Office of Management and Budget. At about the same

Daniel S. Goldin holds model elements of the project for which he will most likely be remembered: the U.S.-Russian-European-Japanese-Canadian space station.

to Washington

The ninth NASA administrator has vowed to revolutionize the agency. Nobody said it would be easy.

ROGER RESSMEYER/STARLIGHT

time a TRW official introduced Goldin to Mark Albrecht, the executive director of the Bush-Quayle National Space Council. "I couldn't help but be impressed by the things they were doing at TRW," says Albrecht, "using very cutting-edge technology, reducing costs, cutting the risk and the time to flight—the very things we wanted the government to do. When the vacancy came to be, I immediately thought of Dan."

Goldin's charge was to bring the nation "faster, better, cheaper" programs, a slogan invented by the space council. Smaller programs were to replace the long-term, flawed, expensive projects, like Mars Observer and space station Freedom, that had earned NASA a reputation for failure and inaction. Goldin has vowed to transform NASA—a big job, he says, that will take five to seven years to accomplish.

If the first three years are any indication, it will be a bitter process. The administrator is fighting with scientific associations, aerospace firms, and even his own workforce. He is openly disdainful of the various special interest lobbies that over the last 35 years quietly consolidated their hold on the civil space program.

"Teacups and doilies," he said last summer, referring to the old guard space scientists who opposed his selection of France Cordova as the agency's chief scientist. "Pale, male, and stale" were his terms for the almost entirely white male establishment of engineers, businessmen, and bureaucrats who have set the civil space agenda for years.

NASA/JOHNSON SPACE CENTER

Goldin took charge of NASA in 1992 at the behest of Dan Quayle, then head of the National Space Council. Since then he has brought Russia aboard the space station, negotiating with Russian space chief Yuri Koptev (middle), and taken the space program on the road, along with some of its practitioners like astronaut Charles Bolden.

An outsider when he came to Washington, Goldin appears to have remained one. It's a role he is comfortable with. Raised in a working-class Jewish household in the Bronx, Goldin says he never seemed to fit in. Progressive myopia prevented him from playing contact sports; a doctor had warned his mother that he could go blind. So while the other neighborhood kids shot baskets on the schoolyard court across the street from his house, he stayed inside, where a strict father made him read or listen to opera. What Goldin lacked in athletic prowess, he made up for in scholastics. He skipped a grade, making himself more of an outsider. "I was intellectually ahead," he recalls, "but emotionally I was behind. So after that, I became even more different."

Goldin launched his chief assault on NASA science-as-usual in October 1992, when he dismantled one of the agency's biggest program directorates, the Office of Space Science and Applications. Goldin took the OSSA

and its $3 billion annual budget away from Lennard Fisk, a widely respected physicist with a large, loyal, and eventually vocal following, and split it into smaller offices. By breaking apart the OSSA, Goldin alarmed various research groups, which competed for missions and projects. The space science working group of the Association of American Universities, which represents 60 research institutions, complained to Congress in 1992 about Goldin's reorganization. Group chair Glenn Mason says scientists were concerned that splitting the NASA science program into several divisions would weaken the program politically. "It would not fare as well as it would have otherwise within NASA," he says. "It was a bureaucratic invitation for less coordination, more in-fighting. And there was a lot of multidisciplinary science among the different programs that needed to be brought together. Since then, the agency's budget has suffered and the science program has been hit particularly hard."

Fisk, who is now the chairman of the department of atmospheric, oceanic and space sciences at the University of Michigan, pointed out recently that there is never enough money for all the missions scientists would like to do, and "one of the things the OSSA had done well was to develop a strategic plan that achieved some balance among the disciplines."

In today's political climate, the breaking apart of bureaucracies is viewed as an absolute good, and Goldin has earned general approval for shaking things up at NASA. But according to Mason, "he's introduced a lot of volatility into the planning process, which makes it difficult to know the agency's policy today and what it may be tomorrow. The level of chaos is such that it's hard to know how to plan.

"If you go into an organization and lots of folks under the boss are unhappy, it's not a good situation."

The unhappiness surrounding the breakup of the OSSA and its management of science programs was due in part to the departure of Fisk, who left NASA several months after being named chief scientist. The job is a key advisory position with responsibility for policy but not programs, according to NASA spokesperson Laurie Boeder.

Goldin's trouble with the OSSA started well before he arrived at NASA, back during the debate over the Earth Observing System. As head of OSSA, Fisk strongly defended large satellites for the EOS, according to Greg Canavan, a physicist at the Los Alamos National

More conscious of establishing a public presence than previous administrators, Goldin makes appearances at events like the Experimental Aircraft Association's Oshkosh fly-in (below). He works hard explaining NASA's mission to Congress and, through the media, to the rest of the citizenry.

WILLIAM C. INGALLS, NASA (1)

NASA (2)

Laboratory who served on the 1991 EOS review panel. That put Fisk at odds with Goldin and the TRW study, which Canavan says influenced the panel to recommend against the big satellites.

Goldin says that someone at NASA tried to silence TRW's proposal. "I don't have clarity on who said what," Goldin told me last May, "but I can tell you that some senior NASA officials went to the highest level of executives at TRW and sent this message: that I was to back off. It's absolutely true."

After Fisk's departure, the tension at NASA headquarters increased as other managers were shifted from their positions, or "Fisk-ed," as agency wags put it. When I asked Goldin about the morale problems, he pointed out that the agency's 1994 budget projection had just dropped from $17.4 billion to $14.5 billion. "In a six-month period, you tell me how you can maintain confidence and morale among employees if you're taking out $3 billion. It's devastating," he says.

Goldin's success, however, will not be measured by the cheerfulness of his workforce but by the missions that NASA accomplishes while he leads. And, true to his word, he has instituted programs that encourage the development of smaller spacecraft and more efficiently managed projects. The first is a new class of solar system exploration missions, Discovery, that limit cost to $150 million, development to three years from start to launch, and weight to the size that can be launched on a Delta rocket (see "Little Launches," June/July 1993). In NASA's 1996 budget request, another new class appears: New Millennium Spacecraft, small technology demonstrators with a first-year allocation of $30 million. It is too soon to tell whether these missions will escape the delays and overruns that brought Goldin to Washington in the first place. The first Discovery-class spacecraft, Mars Pathfinder, is now being developed by the Jet Propulsion Laboratory in California and will not be launched until December 1996.

Goldin got a dramatic opportunity to prove the "faster, better, cheaper" concept when the $1 billion Mars Observer failed in August 1993 on its way to study the planet. His response to the disaster indicates the constraints within which a NASA administrator, even one who is "an agent of change," must work. He quickly announced his intention to send another spacecraft to Mars and asked scientists and engineers to find a way to get another probe ready by the next launch window in October 1994, or, if that proved impossible, by the one after that in 1996. The substitute flight quickly triggered a competition between two groups of satellite builders: those who advocate risk and change and those who believe in caution and experience.

A group of military satellite managers from the Pentagon's Ballistic Missile Defense Organization offered to save the day. They had developed Clementine, a $75 million, 500-pound spacecraft scheduled for launch in January 1994 to demonstrate miniaturized sensors and electronics. The BMDO group offered a second Clementine platform for an October 1994 Mars flight.

A Senate committee ordered NASA not to purchase hardware from the Department of Defense. Instead, Goldin appointed a team to study competing ideas for building a replacement, which included another BMDO-developed spacecraft as well as a plan to build a Mars orbiter with some of the Mars Observer's spare parts. Based on the team's recommendation, the Jet Propulsion Laboratory issued a 700-page document asking for proposals for the spacecraft. Martin Marietta, the company that built Mars Observer, ended up with the job. If the new Mars Global Surveyor reaches its destination in 1997, Goldin's caution will be praised. If, like its predecessor, it fails, his critics will have grounds to wonder what exactly has gotten faster, better, and cheaper.

The Clinton White House has backed

Out With the Old...

Space station Freedom was born when Ronald Reagan was president. *Its last iteration had*
- 9 truss segments
- 3 pressurized lab modules
- no Russian elements
- no exterior ports for docking payloads
- 56 kilowatts of power, and would have weighed
- 600,000 pounds.

It would have been
- launched in September 1996
- assembled with 21 space shuttle flights
- serviced only by the space shuttle
- orbited at an inclination of 28.5 degrees (to maximize the shuttle lift capability)
- ready for occupancy in 2000, and
- crewed by four.

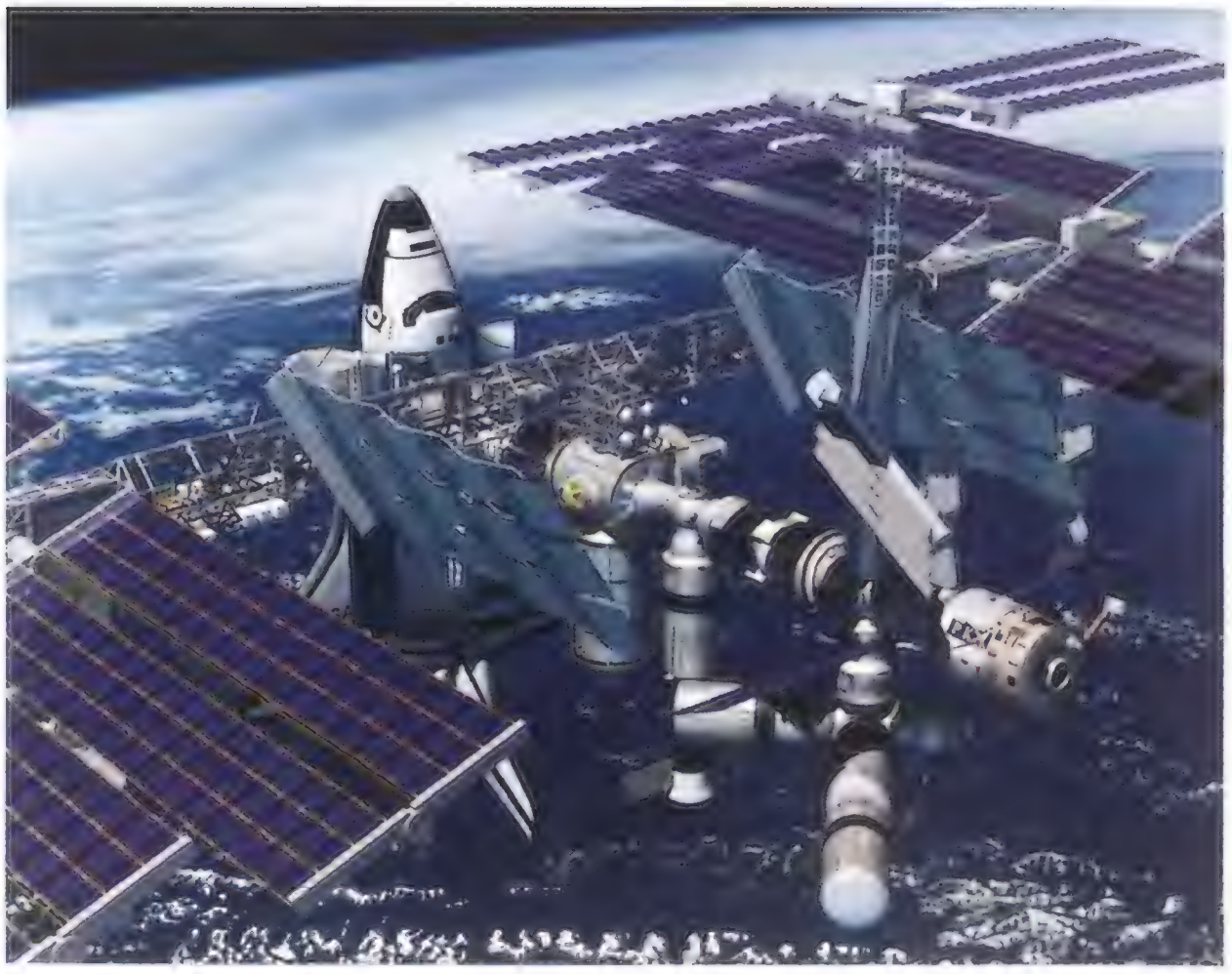
It would have cost
- $20 billion (plus $12 billion spent in 1984–94), and
- $2.5 billion annually to operate.

...In With the New

The international space station is the very latest design, created at Dan Goldin's direction. *It has*
- 8 truss segments
- 7 pressurized lab modules
- a Russian power platform, cargo block, service module, airlock lab modules, and crew return vehicles
- 6 exterior ports for docking payloads
- 110 kilowatts of power, and will weigh
- 886,000 pounds.

It will be
- launched in November 1997
- assembled with 21 U.S. flights, 15 Russian, 1 European, and 1 other
- serviced by the space shuttle and Soyuz, Proton, Progress, Zenit, and Ariane rockets
- orbiting at an inclination of 51.6 degrees (reducing the amount of weight that the space shuttle can carry to it)
- occupied in 1998 (3 people), and
- crewed by six.

It will cost
- $15.3 billion (plus $12 billion spent in 1984-94) and
- $1.3 billion annually to operate.



Goldin so far, even though he was a Bush appointee. Lionel "Skip" Johns, associate director of the White House Office of Science and Technology Policy, says the administration knew that Goldin would cause dissension but that "it was clear Dan had a notion of how to make NASA an agency that the nation could be proud of. He had the courage to face the political challenge.

"It was evident that NASA had been nominally unmanageable for more than a decade," Johns says. "Headquarters had become inconsequential. The centers reported to no one. Or to Congress. They were more familiar for second-rate science than for being centers of excellence."

Near the end of his second year as administrator, Goldin turned his attention to the management of the 10 NASA centers, and in January 1994 he removed half of the center directors. They were focused, he says, on protecting turf and local jobs instead of on achieving excellence in a national program. "If you look at what I inherited," he says, "every center did everything because they were in a survival mode: 'This is what is necessary to get through from year to year.' "

Ironically, Goldin began his own career at a NASA center. After earning a bachelor's degree in mechanical engineering from City College of New York, he went to NASA's Lewis Research Center in Cleveland. There he worked on spacecraft propulsion projects from 1962 to 1967, when he left to join TRW, Inc. He stayed at TRW for 25 years, spending most of that time in the classified world of military intelligence satellites and climbing the corporate ladder to the rank of vice president. When he was tapped to run NASA, he was heading TRW's Space and Technology Group in Redondo Beach, California.

Goldin hasn't cut the industry in which he worked any slack. The NASA-contractor relationship that once was characterized by a comfortable complicity is now more adversarial. This is partly due to Goldin's push for procurement reform. Industry executives complain that some of the reform measures treat cutting-edge research like straightforward production, but Goldin says his initiatives are not directed toward research-and-development programs. The discomfort in the industry has been intensified by Goldin's occasional public displays of ill temper.

One ugly scene involved a confrontation with a Hughes Space and Communications executive at a social event. Goldin remembers that the argument was over Hughes' track record on NASA projects. "What I said was, 'You've overrun almost every contract you had with NASA. It's unacceptable,' and I called out the circumstances," Goldin explains. As he recalls the incident, his voice rises as if he's about to renew the confrontation.

Goldin might be forgiven some testiness about cost overruns. A 1992 General Accounting Office study of 29 NASA projects reported that costs ran, on average, 75 percent higher than original estimates, and Goldin put NASA contractors on notice. "We will hold you accountable for what you sign up to deliver," he said.

Like many of the changes Goldin is attempting, this one is easier said than done. He has made progress. He has linked the amount of profit a company can earn to the performance of its hardware and revised contract requirements to focus on the product or service rather than on the process to achieve it. He has not, however, been able to make contractors pay for mistakes. As it stands now, unless the agency can demonstrate deliberate malfeasance, like fraud, NASA pays to repair any problem that occurs in a project. Goldin wants the contractor to share those costs. The industry has fought the change, and several years after Goldin proposed it, it is still under review.

Goldin says the people resisting him have spent too many years living off the space program. "The space program is

not owned by the people who work on it. It's owned by the American public," he says. "The NASA administrator is [supposed to be] a person who'll say what he's got to to protect industry. Positive things," Goldin says, shaking his head. "That's living in fantasy land.

"Is a NASA administrator supposed to be a nerd who comes in in a white shirt and pinstripe suit with wing tip shoes and only focuses on the technology...? The problem we've had [in] NASA is that we haven't justified in the new world why we exist."

Former Marine general Jack Dailey, Goldin's second in command, says that within NASA resistance has come mostly from employees who had spent 12 to 15 years working on a single program. "People in some cases said, 'We'll just wait this guy out 'cause he won't be here much longer,'" Dailey says. "They were wrong."

Goldin survived a transition in administrations, but he has continued to face opposition to some of his cost-cutting measures. Goldin's first priority upon taking office was to rein in the shuttle and space station, which together threatened to eat up almost half of NASA's $14 billion annual budget. Less than a month after taking office, he hired former Marine general Jeremiah Pearson to manage the programs, naming him the associate administrator for spaceflight. When Pearson took over, the shuttle budget was $4 billion; this year, it is $3.1 billion, but there has been no reduction in the number of shuttle launches. Goldin and Pearson also reduced the shuttle workforce by roughly 4,500 contractor and 1,000 civil service jobs.

Continuing pressure on the shuttle program triggered internal dissent over quality control and the safety of the astronauts. But at a budget briefing in Washington in February, Goldin said: "Safety governs everything we do. It's our top priority." He said he had appointed two teams to review shuttle operations and that they were "looking for ways to significantly cut costs while achieving safety equal to or better than today's level." If they find that safety requires more money, he'll add money, he said.

Pearson resigned from NASA last November. In December, Kennedy Space Center director Robert Crippen, a former shuttle commander who had served at the Florida launch headquarters for three years, announced his resignation. Crippen told reporters his decision was prompted only in part by anxiety about the budget cuts.

The pressure on the shuttle has been slight compared with the upheaval in the space station program. NASA had spent almost eight years and $10 billion designing space station Freedom. It took Goldin just a few months to replace it.

In the transition from the old space station to the new, NASA cut 1,300 contractor and 1,290 civil service positions from the program, closed the station management office in Reston, Virginia, consolidated station management at

SCOTT ANDREWS

Space shuttle operations take 22 percent of NASA's budget. Goldin has asked two teams to study ways of reducing that cost. Opposite: In a quiet hallway at NASA headquarters, Dan Goldin, aspiring space legend, talks with a man who's already made the grade: Walter Cronkite.

the Johnson Space Center in Houston, and brought Russia into the project. The process taught Goldin a lot about the ways of Washington. "I could not believe how many people have their finger in the NASA pie," he told me. "Congress—not just the members but the staffers—the corporations, the press, the American public. And everyone has a very focused view of what needs to be done, with incredible certainty. I just misread how much preparation work you have to do to communicate with these people."

Goldin convened a space station review team just four months after he came to NASA but restricted the review to methods of launching the station. The subsequent overhaul of the space station, conducted after Bill Clinton was elected, led to speculation that station supporters on Capitol Hill had squelched the first review. But when Goldin revamped Freedom, both the White House and the Congress backed his plan. "We decided to bet on him," says the White House's Skip Johns. "He hasn't disappointed us."

Even Goldin's detractors concede that his gift for communicating has helped the space program. Goldin spent countless hours on the Hill and visited members of Congress in their districts, rallying support for the redesigned space station, which won an impressive victory in 1993 in both the House and Senate and survived a difficult challenge last year. It is now slated for assembly beginning in 1997; the first piece will be a Russian-built, U.S.-bought power and navigation module, to be launched from Kazakhstan on a Proton rocket in November of that year. The station is supposed to be ready to host its first three-person crew in May 1998, two years earlier than Freedom would have been; however, it will not be complete until 2002, two years after Freedom's target date. Once assembly is complete, it is scheduled to operate only 10 years instead of 30. And Goldin has promised the total U.S. investment from this year forward will be $15.3 billion, about $5 billion less than before.

So the new International Space Station appears to be a smaller program than Freedom, barely faster, and apparently cheaper. But relying on Russia's contribution is a risk that could increase cost and time. And one member of the redesign team, who requested anonymity, says the station budget that Congress approved is "false without a doubt" and will not hold. Whose figures are correct will be easy enough to see when the costs are tallied as the station is completed.

For hard evidence that the agency is running missions on time and within budget, 1997 will be the telling year: Mars Pathfinder will make landfall in June; Mars Global Surveyor will enter Martian orbit in September, and the first module of the international space station will begin its orbital operations in November—if NASA has become an agency where things work again. But Goldin, wisely, looks far beyond 1997.

He makes a point to ask as many people as he can what they want from a space program. Not surprisingly, the answer is only sometimes "a space station." What people most often ask him, he says, is whether life exists elsewhere.

So he talks of pushing outward to the next destination. He says only three missions are feasible: a return to the moon, a research station on an asteroid, or a trip to Mars. "We should work on the space station so one of these three things can happen," he says.

His own favorite future project, one that the agency has not sought approval or money for, is to launch telescopes into orbit with instruments more advanced than those available today. One of those instruments might send back the picture of an Earth-like planet within 10 light-years of this solar system. "I get goose bumps just thinking about it," he says.

WILLIAM C. INGALLS/NASA

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COMMENTARY:

The Price of Peace

The cold war was cheap, as wars go. At least for the United States it was. U.S. defense spending since 1945 totals about $14.5 trillion in 1994 dollars—about seven percent of gross domestic product. By comparison, the Soviet Union spent an estimated 18 percent of GDP during the cold war.

The "peace dividend" expected at the end of the cold war has thus turned out to be a disappointment. The defense budget did not have all that far to fall. Most nations throughout history have spent about five percent of GDP on the military in peacetime; U.S. defense spending is now down to less than four percent of GDP and is unlikely to drop much further. In fact, in the near term it is more likely to rise.

But where should it settle? How much defense is enough for the world's lone remaining superpower? There are three key ways to address that question. The first measures the need, the last measures available resources, and the second attempts to bridge the gap between the two.

The measure of need, something known in economic terms as "demand pull," pegs defense spending to military threat. It matches our military expenditures with the danger abroad in the world. The problem, of course, is measuring threat. Which, for example, poses the greatest danger to the United States: the nuclear arsenal of the former Soviet Union, the army of North Korea, or a religious fanatic with a bomb in the trunk of his car?

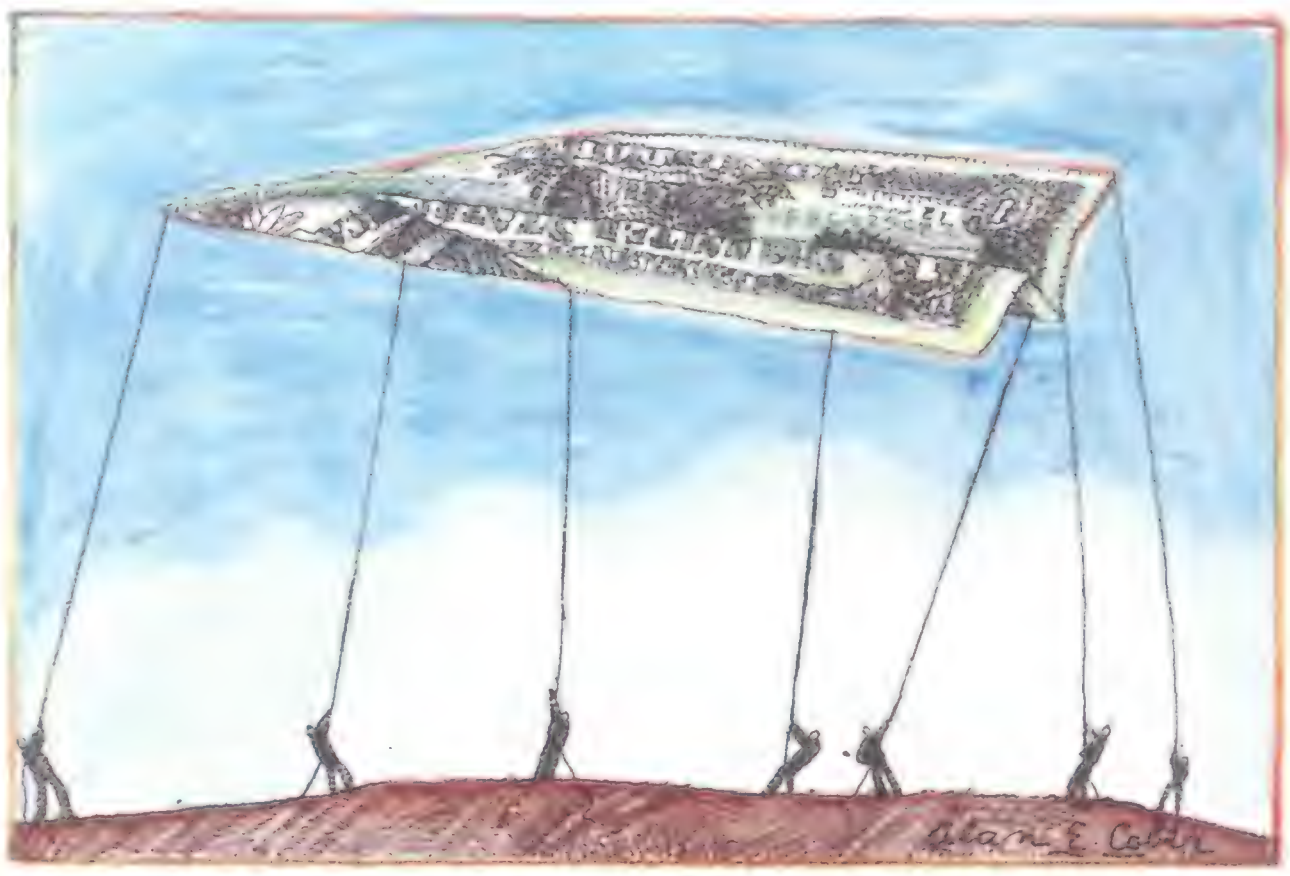
If you guessed "all of the above," then you understand the American security dilemma at the end of the 20th century. The likelihood of any one American being killed by foreign enemies is inversely proportional to the killing power at the disposal of those enemies. We have a small risk of enormous casualties and a high risk of low casualties.

The countries of the former Soviet Union still possess the most dangerous arsenal outside the United States, but the chances of their firing on the United States are minuscule. Russia and China both have larger conventional armed forces than the U.S., and North Korea is not far behind, yet a shooting war with any of these states is unlikely. Terrorists and petty warlords in developing nations have far more modest resources at their disposal, but the probability of more assaults like the bombings of the World Trade Center and the U.S. Marines' barracks in Lebanon is very high.

Therefore we must continue to defend ourselves against all three threats. We need a nuclear arsenal, a conventional military force, and a capability for low-intensity conflict or what are known as "operations other than war." In aerospace terms, this means ICBMs, stealth fighters, and helicopters. But to say that we need an array of military resources does not answer the question: How much of each do we need? Threat is in the eye of the beholder. It defies consensus.

Another way to answer the question "How much is enough?" is what might be called the savings spread. This technique employs economy measures to close the gap between the dollars available for defense and the costs of adequately meeting the threats facing the nation. Three versions have been tried. All have precedents in the cold war. All have shortcomings.

The technological fix, which has a long history in this country, seeks technological solutions to social, political, or economic problems. In this case, dual-use technologies are invoked to help us meet the defense needs we are unable or unwilling to pay for. Can we not, for example, pioneer computer technologies that not only leverage our military power but also increase our competitiveness in the world economy? The classic example is the U.S. aerospace industry, which grew to world preeminence in the middle of the 20th century by exploiting research and development funded by the military. This formula gave us the world's best military aircraft and a commercial export industry that shored up an otherwise sagging balance of trade. High-tech weapons are force multipliers that enable us to defend our interests with machines instead of people, and they spin off technologies that achieve other, more peaceful national goals.



ALAN E. COBER

How much defense does the U.S. need? Alex Roland proposes an answer to this increasingly difficult question.

Such a formula does indeed hold continuing promise, but it has limits. Many scientists, engineers, and students of science policy, especially those who scruple to accept military funding themselves, worry that research bought by the military bends our scientific and technical communities down paths that may not be optimal for the nation's economic growth. And some technologies simply do not lend themselves to dual use. Microelectronics may be a nice fit; the civilian applications of nuclear weapons and heat-seeking missiles are less easy to imagine.

A second subsidy of our defense establishment comes from selling our weapons abroad. One hundred fighter aircraft to meet America's needs can be a boon to the aerospace industry; 300 to meet the world's needs can be a bonanza. Unit costs fall precipitously as production runs increase. Throughout the cold war, the United States subsidized its defense establishment by selling obsolescent weapons to its allies. The market for such weapons has hardly declined with the cold war's end.

The problem, of course, is that this solution requires us to embrace the role of the world's leading merchant of death. During the cold war, we could rationalize selling arms as a way to counter Soviet arms sales. When the cold war ended, George Bush committed the country to withdrawing from the international arms bazaar. But the rhetoric outran the reality. Fully 70 percent of the world's arms sales now originate in the United States, and two-thirds of U.S. weapons go to countries of the Third World. Almost any night on the evening news we can see a conflict somewhere in the world in which both sides are killing each other with American-made weapons: Peru and Ecuador, for example. Although lightening our defense burden, this must offer us only cold comfort.

The third economy measure under the rubric of savings spread was employed in the Gulf war. As the leader of a large United Nations-sanctioned alliance, the United States committed the majority of the troops and equipment to subdue Saddam Hussein. It surely made sense; after all, we had the most and the best-equipped forces available. But because we did not have the greatest stake in the outcome, we called upon those nations with high stakes but slim military resources to reimburse us for the cost of the operation. By some accounts, we actually collected (or at least were pledged) more money from our allies than the war put us out of pocket. If we are going to use our military establishment to play policeman to the world, it seems reasonable to expect a subsidy from those we protect.

The peace dividend at the end of the cold war has turned out to be a disappointment.

But that, of course, makes us mercenaries—another role with which we are painfully uncomfortable. Being a gun for hire reduces war to a business and a just war to a mockery. Inevitably one becomes more interested in the rent than the purpose.

The third alternative, the one I recommend, might be called supply side defense. The United States should index its defense budget to world military expenditures. The U.S. controls about 20 percent of the world's wealth. It follows that we should account for 20 percent of the world's military spending. In 1991, the last year for which world figures are available, the U.S. spent about 23 percent of the world total. This represented 4.8 percent of GDP. Since world military expenditures have been falling since the late 1980s, even before the end of the cold war, it is reasonable to estimate that 20 percent of the current figure would amount to somewhere around 4 percent of GDP—about what the country is spending now, in other words.

Whether the money now being spent is apportioned properly is beyond the scope of this essay. Recent efforts by the Department of Defense to identify and nurture key technologies, especially information processing, are a healthy sign of the strategic thinking that will be necessary. Indeed, one benefit of the formula suggested here is that it will force military planners to measure threat carefully and distribute resources wisely.

Pegging our defense budget to world military expenditures has other merits as well. First, if you assume that all threat is proportional to money spent on weapons, then you have a benchmark for measuring the total potential military threat other nations present to the United States. Second, with such a policy, the United States could encourage other countries to lower their military spending by promising to lower ours proportionally; nations that insisted on spending disproportionally on military force could become targets of international pressure and even sanctions. Third, it establishes a defense ceiling under which the military services would be free to select the best arsenal and force structure to meet the threats they perceive. Finally, we could start conceiving of our security in terms of the global community instead of positing individual enemies or alliances potentially arrayed against us. We should, in short, carry our share of the load, no more and no less.

The author is a professor of history at Duke University, where he teaches military history and the history of technology.

The Mosquito Coast

There's an air war going on in western florida.

by Tom Huntington

Photographs by Cameron Davidson

They emerge in swarms from swamps and marshes and pools of stagnant water, in search of human blood. Once ingested, the precious fluid will nurture their eggs, which bear the next generation, and so the cycle will continue.

They are mosquitoes, and there is a war going on in Florida to annihilate all 47 of the species that reside in Lee County on the state's western coast. The air assault started slowly, with a single Stearman biplane, then grew to a small fleet of helicopters and fixed-wing craft. But the enemy shows no signs of surrender.

The insects have proven to be tenacious foes since the day Everett Link kicked off the aerial hostilities. On August 9, 1949, Link sprayed 600 gallons of a DDT mixture from

The last sight a Lee County, Florida mosquito sees: the county's fleet of Douglas C-47s flying line abreast and laying down a fog of insecticide.

Acres of watery marshes attract 47 varieties of mosquito to the west coast of Florida. Helicopters like this Bell UH-1 Huey supplement the fleet of fixed-wing sprayers (above).

his Stearman. "Mosquito-Free Citizens Delighted as DDT Spraying Wipes Out Pest," the Fort Myers newspaper reported the next day. The paper, it turned out, was a little optimistic.

Despite Link's mosquito massacre, the insects continue to bedevil the citizens of Lee County, and new aerial operators have risen to take up the gauntlet. The Lee County Mosquito Control District, which was formed in 1958, still fights the battle on the ground as well as in the air. And every year the mosquitoes return, particularly a nasty saltwater variety known as *Aedes taeniorhynchus*, which makes its home in the coastal marshes that have made Lee County such a mosquito haven. "The mosquitoes that give us the most problems lay their eggs in damp soil knowing it will flood soon," says District director Bill Opp. "They all come off at the same time and we're overwhelmed." On his desk Opp has a clipping from a local paper: "Mosquito plane 'drenches' Cape kids; spray called safe."

"You have to be very careful how you use pesticides," says Opp. "They overapplied DDT after World War II and the mosquitoes acquired a resistance to it really quickly." Today Mosquito Control uses mostly

Malathion over residential areas to combat adult mosquitoes. It's never sprayed over wetlands lest the larvae acquire a resistance to it; a substance called Abate is used against the larvae. An entomologist plots out the aerial spraying strategy, working from reports provided by inspectors in the field as well as complaint calls—up to 500 a day when the mosquitoes are out in force.

Mosquito Control operates from a former World War II training base in Buckingham, Florida, just down the road from Fort Myers. From this headquarters a team of seven full-time pilots and up to 10 part-time copilots spends its summer months attacking the winged pests.

Helicopters do most of the flying, either transporting inspectors into the field or flying spray missions. The helicopters' tanks hold only five minutes' worth of pesticide, so their pilots are constantly landing to recharge. The workhorse is the Bell UH-1 Huey; the District had been operating the B model, which is no longer in production. Last year it updated its fleet with seven H models from the military, but it still maintains four old piston-engine Bell 47s and two newer turbine-powered Model 206 JetRangers. ("If you're looking to get a day's work done, fly

Top right: Chief pilot Charlie Morrison (at far left) and his fliers, all retired military men, are comfortable with round engines and propellers. The C-47s are old but regularly refurbished, with junkers supplying the parts.

the Huey," says chief pilot Charlie Morrison. "If you're looking for comfort, fly the JetRanger.")

But there are times when the helicopters aren't enough. When swarms of adult mosquitoes emerge from the pupal stage to make life a living hell for the residents of Lee County, Mosquito Control turns to the weapon of last resort: its fleet of Douglas C-47s. Dennis Moore, the District's entomologist, calls them the "big guns." Moore works out of a small windowless office (on the bookshelves are titles like *Mosquito Ecology: Field Sampling Methods* and *Toxicology of Insecticides*), pinpointing the trouble spots for the day's spraying.

Five of the District's heavy aircraft are C-47s; the other lookalike is actually a Douglas C-117D Super Goose (sometimes called the "Goon"), a military version of the Super DC-3, with Wright engines and a stretched fuselage. Equipped with 800-gallon tanks inside a stripped-out cabin, each airplane can spray for 40 minutes and cover 4,000 acres. They always fly in the legally mandated time: no later than two hours after sunrise and no earlier than two hours before sunset. Flying up to five abreast at treetop level, with a fog of insecticide streaming from the spray systems installed in the engines' exhausts, the big airplanes can be an arresting sight. "You think, either we're being invaded by a country with unsophisticated aircraft, or these planes are about to crash," says District pilot Tom Savage. Like all his colleagues, Savage is rated for both airplanes and helicopters, but most of his experience is with the latter. A helicopter pilot in the Army, Savage flew for a television station in Buffalo before heading south. For him, the big twin-engine C-47s are a change of pace from the helicopters. Flying a C-47, he says, is like driving a truck—without power steering. "You have to have broad shoulders to fly those. There are not many hydraulics."

"It's an excellent airplane," says chief pilot

Helicopters do most of the flying, but they carry only five minutes' worth of mosquito doom. The county's 11 mechanics use the slower winter months to repair and overhaul the fleet.

Charlie Morrison of the C-47s. A maintenance man in the Air Force who didn't learn to fly until he left the military, Morrison went on to fly stints for the Lee County sheriff's department and for commercial operators in Alaska and Colorado.

"We get surprisingly good reliability from them," Morrison says. "If you're going to have a problem it's going to be an engine problem." Unfortunately, the operation that used to overhaul the C-47s' Pratt & Whitney engines has closed down. The District is looking for someone else to do the work.

Maintaining his fleet of flying antiques is not Morrison's only worry. "We fly very low level, so you have to be aware of obstacles and wires," he says. "The areas we spray are not in nice straight lines like crops. Being aware of where you are and the orientation of the spray is a challenge in this operation."

Peak season for spraying is May to November. The winter is largely down time for the pilots, but the 11 mechanics use the

Like large-economy-size cans of Raid, tanks holding insecticide and aviation fuel supply a maze of pipes leading to fill-up points (above). After topping off, the C-47s fly in early morning and late evening, when winds are calm.

intermission to inspect and refurbish the aircraft. In the hangar, spare C-47 wingtips hang from the ceiling, along with spare helicopter frames. Chief mechanic Dick Scott's team is also in the process of stripping military radios and avionics from the new Hueys and adding pesticide tanks and spray nozzles, the booms for which extend from the helicopter like vestigial wings. A Bell 47 lies almost disassembled on the shop floor. "The big thing is corrosion," says Scott. "It's such a corrosive environment with the saltwater. The helicopters land with their gear right in the water."

It's a humid environment, and each C-47 has an ordinary household dehumidifier unit installed inside. The sun and humidity also take a toll on the fabric covering of the C-47s' control surfaces, and it has to be periodically replaced.

So the war goes on, just as it will next year and the year after that. There is no end in sight. *Bzzzz.* Slap!

The Magnetic North

by Laurence Gonzales

Photographs by Clark James Mishler

Alaska offers some of the most challenging bush flying in the world, yet some pilots can't resist its attraction.

Kotzebue, Alaska, is a village of plywood shacks, house trailers on cinderblocks, and log cabins. Every other residence is bedecked with weathered hides and horns, and in the yards forsaken sled dogs whimper on their chains. Mudholes pock the gravel streets. The only pavement other than the airport ramps is the parking lot of the National Bank, where Eskimo girls sheathed in Spandex flow back and forth on rollerblades at sundown.

One Sunday morning, in search of a bush pilot named Jim Rood, I wandered to the eastern end of the local airstrip and watched the sun rise. Here, 30 miles above the Arctic Circle, it didn't come up until after 8:30, and then it didn't rise so much as stall. Kotzebue was losing more than ten minutes of light every day, and within a month the sun wouldn't be coming up until noon.

I walked around a hangar that bore a sign reading "Alaska International Air." Climbing a fence to get past airport security, I found a small man-size door. I pulled it open and a fetid odor filled my nostrils. As my eyes adjusted to the darkness, I counted five moose and then lost track of the caribou that lay slaughtered and decomposing on wooden pallets. It was the unclaimed bounty of visiting hunters. Some of the carcasses were wrapped in cheesecloth game bags or shiny black plastic garbage bags, and others were left out in the open in that great cavern of silver insulation, large enough to hold four or five DC-3s.

I pushed past a dozen dog cages, a shattered bubble helicopter, and meat crates labeled "TOFU WO CHONG SF, CA." Far in back was a large shop and a small office with an electric space heater, a telephone, and a grease-pencil board with upcoming trips scrawled across it.

Presently, a red Piper Super Cub came taxiing up the adjacent ramp. It wore a set of "wrinkle-walls," Racemaster drag racing tires so deflated that the sides caved and cracked. "I'm sorry you saw so many people," I overheard the pilot, Jim Rood, say to the hunter he was returning to civilization. In his late 50s, the bush pilot wore eyeglasses, a blue jumpsuit, and a black baseball cap with his company's logo: Northwestern Aviation.

I had been invited to accompany Rood while he scouted landing sites on the Agashashok River. He motioned for me to get in the airplane and muttered something about the fire extinguisher under his seat. The interior was clean, thanks to the tarps he uses for carrying game. His largest item of luggage was his survival bag. We taxied out to the 5,900-foot runway. He turned the Super Cub sideways, and for a moment I thought he was running up the engine. Bush pilots always take off and land as directly into the wind as possible, but I still wasn't prepared when he proceeded to take off *across* the 150-foot width of the asphalt runway.

Cruising out over Kotzebue Sound into a bank of low thin clouds and haze, Rood held the stick between his knees and poured himself coffee from a thermos. On the way to the Agashashok, Rood told me his story. So often a bush pilot's tale turns on the meeting of a woman, and Rood's was no exception. (I met no female bush pilots, although I heard of one or two.) Rood had left a machinist's job in upstate New York to come to Anchorage in 1969. There he met the daughter of a guide who owned two Cubs.

JEFF SCHULTZ/ALASKA STOCK IMAGES

The rugged beauty of the 49th state attracts a certain breed of aviator. Lowell Thomas Jr. (left) flies a Helio Courier to deliver climbers to Mt. McKinley, which is also known as Denali. Local pilots call it "the Hill."

FRED HIRSCHMANN

Alaska has nearly 600 airports, but bush pilots frequently rely on gravel bars (above). Jim Rood (right), who left a machinist job in upstate New York to come to Alaska in 1969, is a master at landing his Super Cub on river bottoms.

"I arrived with five hundred dollars and I didn't know anybody," Rood related to me over the headsets. "Then I met him. He was a good-hearted con artist, and the girl was a wild child. I worked the season and used the Super Cub to get my license. It was an outlaw operation. I flew side by side with him, flying formation."

In 1973 Rood went to Kotzebue for a two-week job ferrying oil exploration crews for Buck Maxin, another old-time bush pilot. Rood has been there ever since. He worked for Maxin until 1978, when the older pilot retired and Rood bought the coveted charter business license. But apparently Maxin couldn't stay away. When I was there, he was at the other end of the field flying float planes. He and Rood aren't on speaking terms.

Rood has two sons in Kotzebue from different women he calls "Eskimo girls." He's living with another woman now. "I still maintain contact with the boys," he said, "but I don't get along with their mothers too well." I asked Rood about loneliness, and he replied, "I like to go where nobody knows me and forget everything."

The sky was gray and we fell through whistling snow to a river bottom called Hugo Creek, then followed the fork upstream to a narrow crevasse it had cut in the tundra as if acid, not water, flowed among the stones. Up the Agashashok River we flew in a small valley of rolling brown tundra with hundreds of caribou fleeing our footprint of sound. Chalk white gravel bars appeared in shallow serpentine channels of riffling waters. Flying within a wingspan above the gravel and gin-clear water, the Cub advanced in moth-like movements. Gravity and wind tugged on us as we pivoted slowly and seemed to almost stop on air as Rood looked over the gravel bar for changes since he was last here. "Aw, the wind's shifted," he complained, and banked the other way.

Then we were earthbound. So effortless was Rood's flying that I scarcely understood what he had done. One moment we rotated on a wingtip. The next we were walking a gravel bar.

"I spent four hours cleaning up this strip the other day," Rood said as he inspected the gravel bar with a proprietary air. Bush pilots find their own places to land and claim them by clearing logs and large rocks, and perhaps putting up a bit of cloth on a stick for a wind sock.

There was ice in the stream. We walked away from each other, and Rood unzipped his fly and urinated on the stones. Then he blew his nose loudly into a white handkerchief. The bush pilot knelt at the stream and put his face in the water and drank like a wolf. "I'd like to leave you here for a few hours just to enjoy the landscape," he said, "but I'm afraid I might not get back."

I climbed back in with Rood and we lifted off the river bottom. We flew low up the river, searching for new places to land. "This'd be a good airport," Rood said about one gravel bar, "except for a few big rocks." Surviving the landings was not the biggest problem. It was getting out again if the airplane was damaged in landing.

We retraced Hugo Creek to the south, and something caught my eye. "I think there's a hunter down there," I said.

"No, I don't think so," Rood said, circling.

"Well, there's a dead caribou," I said. He dipped a wing.

"Look," he pointed. Two wolves had killed the caribou and were sharing it with a dozen carrion birds. At our approach the wolves scattered, twisting and snarling up at us. One was an enormous black male, bigger than any dog. Its companion was a beautiful silver female. We circled the scene of the kill, then veered away as the wolf couple vanished among the clefts of stone on the hillside.

Loading cargo (above) and sitting at a computer to work on company business (below) are the other side of the flying. When not working, Kerry Cope (far left) lives with his roommate in a trailer he calls home.

Across the field from Jim Rood's operation is another bush pilot service, Alaska Island Air, which delivers mail, flies charters, and ferries hunters and fishermen into the wilds. Its owner is Mike Spisak. Unlike most bush pilots I met, who gave the outward appearance of men who had come to Alaska to wrestle grizzly bears, the blond, cleanshaven, youthful-looking Spisak gives the impression of being a kid from the suburbs.

The Alaska Island Air offices consist of a shed with white walls, fluorescent lights, a desk with a computer, apparatus for brewing coffee, and an Arctic chart on the wall above a contour map of Alaska. A .22 rifle leaned against a bookshelf in Spisak's small office. "My dog killer," he calls it. Outside on the gravel ramp where the airplanes park, skids of caribou and moose, cut up and packed in crates or in bloody game bags or simply lying out in the open, attract wild dogs.

One morning Spisak's copilot, Kerry Cope, drove out across the ramp in a battered truck to load the DC-3 for a mail run to the villages. Snow gathered around our feet as Cope and I secured skids of Coke behind the pilot's seat with cables and strapped them down with nylon belts. We loaded crates of valve fittings. We carried Lexan panels that caught the wind like kites. We hoist-

ed radio antennas. A bush pilot's work, as often as not, resembles the labor of a stevedore.

After we finished loading the airplane we topped off the tanks from a rusted old fuel truck, which ran out of fuel halfway through the operation and had to be filled itself from a newer fuel truck that moved about the field on a continuous circuit, servicing aircraft. Spisak came out, calling "Clear!" as he shrugged past the pallets, and he was cranking the right engine even before Cope and I scrambled up and strapped in. "I hope you don't have any other plans for today," he shouted at me over the noise of the propeller blades and dropped a spare headset on the floor for me to pick up.

"Why?" I asked.

"Because we're going to Barrow," he said, cranking the left. A huge greasy eruption of smoke filled the air behind us and billowed away in the prop wash, rolling across the ramp like a giant vaporous tumbleweed.

The DC-3 was a 1944 model that still bore the stretcher hooks and ashtrays from its days as a hospital ship for wounded soldiers in World War II. Its interior was a maze of dark green-painted recesses and insulation, padding, exposed wires, and fuel lines. I noticed a small placard that said "Remove tank before going into combat."

"Forty-seven on takeoff," Spisak told his copilot, and a moment later we were rolling down one of the few paved runways above the Arctic Circle. Cope set the throttles, tuning them with a smoothness that made other pilots seem hamfisted.

Spisak steered the big airplane with his feet and let it lift gently from the runway. Cope tilted his head to the side as if listening and moved the throttles by millimeters with thumb and forefinger, setting the requested 47 inches of manifold pressure. The airplane clattered and shook like an angry old bird caught in a flimsy cage.

We departed flat out over the water, topping a small hill. Spisak said, "Gear up" and then "Climb power," and Cope powered up the hydraulic system, then lifted the squat yellow gear lever on the floor. The wheels struggled into the belly with a groan and thump. Cope reduced manifold pressure for the long slow climb, set the red mixture knobs to auto-lean, and delicately, with thumb and forefinger, rocked them back and forth to check that they were locked.

I sat in the jump seat between them. Ancient vacuum tube equipment lay dead inside the radio bay beside me, but the old crank-style automatic direction finder radios were still in use. We flew at 200 feet over a roadless tundra. Infiltrated with lakes, rivers, and

Mike Spisak (below) came to Alaska in 1979 and learned to fly in a Taylorcraft. Nowadays, flying over glaciers like those in the Chugach Mountains (right) is not an unusual trip for him.

pools, the yellow-brown terrain was spongy, pitted, and whorled. Occasional twisting lines of trees marked a river's course. A dozen caribou spilled forth as we dialed in the heading directed by the navigation system and climbed to 600 feet. Bush pilots fly low. One reason they don't often check the weather is that they are usually beneath it. Besides, it's often an academic question: they have to go anyway. The Federal Aviation Administration has a flight service station at Kotzebue, and the National Weather Service office located behind it sends up weather balloons twice a day, but I never saw a pilot obtain a weather briefing. One bush pilot told me, "If you're training a new pilot, you take him out and make him fly the route at 50 feet, because one day he'll have to do it anyway. He might as well know what it looks like."

As we hammered on toward the northeast, Spisak bragged about the old days. "When we started," he said, "we were the biggest bandits up here." In bush pilot parlance, a bandit is someone who operates outside the law, running charter flights without an FAA Part 135 certificate. Bush pilots take pride in their banditry. Of course, now they've all reformed. "The FAA had a picture of me...they used as a dartboard," said Spisak. "We used to fly 7 a.m. until 2 a.m., then get three hours of sleep, get back up, and do it all over again." It's illegal for a pilot to fly more than eight hours each day, but no one I met adhered to that. "We'd log 300 hours a month, fly external loads, you name it," Spisak continued. "Kerry and I were a lot more exciting. You've got to remember that up here everything you do is to make money."

Every bush pilot I met seemed to subscribe to the Get-Rich-in-Alaska fiction. The truth is that more often they live in squalor, in wretched shacks and house trailers, in conditions befitting a wartime outpost. The cost of living is devastating. The pay is spotty. Spisak is an exception. By spending himself at a profligate, prodigious rate, by aggression and lunacy far beyond that of the ordinary bush pilot, he has succeeded in putting together a large operation. Ask him about his dreams and he replies, "This is my dream. I've achieved my dream."

In the distance a settlement materialized: the white gleam of roof tin and black rhomboids of primitive architecture. We made a smooth landing on a gravel strip. A sign on a shed proclaimed "Selawik, Home of the Wolves."

Men in hooded, greasy coveralls arrived on four-wheel-drive Honda ATVs. We unloaded three skids of Coke, Dr. Pepper, and 7-Up, the stuff of civilization in a town that has no roads at all. A wooden walkway led from the gravel airport out among the crude shanties thatched with steel, each issuing a flag of smoke into the clay banks of cloud. In the distance, a yellow diesel backhoe reared up, the frozen and improbable guardian of these forsaken ramparts thrown up in haste against

Floatplanes like the de Havilland DHC-3 Otter have an obvious advantage in Alaska, which has over a hundred seaplane bases.

the nothingness.

We loaded our new cargo, and the men ripping apart the pallets were shrouded in smoke as Spisak cranked the right engine. He hogged the DC-3 out of there, short-field, calling "Gear up!" as we cleared the gravel. Around the corner at 150 mph to a heading of 352 degrees for Barrow, the farthest point north in the United States.

We clambered through clouds on our way to 9,500 feet. A fractal vegetation of ice formed on the windshield. Soon we were driving through snow and I asked Cope if we were on an instrument flight plan. He shook his head. I asked him how we were supposed to avoid hitting someone. "There's nobody else up here," he said.

"Is it legal?" I asked.

Cope shrugged.

Spisak called for alcohol to clear the windshield. I turned the valve but nothing happened. "Maybe it's empty," he said. Cope steadied the throttles and prop, adjusting as we went. The steady throb of the engines shifted, settled, and synchronized once more. He applied a small amount of carburetor heat. The DC-3 required constant attention. Each time Cope pulled the gear lever up, the wheels would sag.

The snow stopped as we proceeded out over the Brooks Range. I poured coffee into styrofoam cups from a beat-up stainless steel Stanley bottle and studied the chart. Except for one tractor trail and a place called Brady, and other than an abandoned cabin here and there, there was nothing for the next 280 miles. The maximum elevation figures showed that 5,300 feet would clear the highest peaks. But the mountains, which resembled a rat's beveled teeth, were nonetheless forbidding and reminded me of Antoine de Saint-Exupéry's novel *Night Flight*, about airmail flights over the Andes.

Spisak got up and tapped me on the shoulder, jerking his thumb at the cockpit. I was to fly to Barrow. I settled into the ancient seat and strapped in, taking the controls, turning left and right to get the feel of things. The yoke was large and felt like the old black steering wheel of my father's 1950 Ford.

The snow began again. We entered an area of turbulence. The two bush pilots joked and drank coffee, and when a hole opened up we could see the Noatak River. "That's that gravel bar that gave me such a hard time last year," Spisak said. We looked down on the tortuous course of the river flanked by intermittent gravel bars and curving pearly tributaries. The automatic di-

rection finder was picking up occasional staccato Russian civilian radio broadcasts.

I backed off on the throttles to begin the long slow descent. I checked the chart. North of Barrow it read simply *Pack Ice*. We were heading for the Arctic Ocean. There is something keen and hard and vivid about flying into a cloud bank at 4,000 feet talking to no one, on no flight plan, with no weather report. Such a ritual as this, as much as anything I'd seen up here, embodies the wilderness of it all, the wildness of this alien land. Pilots (and other people) up here give themselves over to being lost in ways that we can't or won't back home.

Spisak told a story about the days when he ferried fuel to the gold mines in a converted agricultural spray plane called an AgTruck. He was hauling 270 gallons per load, five loads a day to a one-way strip with a bluff at one end and no way out when the wind was blowing wrong. Once, after he had been unable to get in for several days, the miners called to let him know he could come on out, the wind was just right. Spisak was naive back then and had no way of knowing that they were lying just to get fuel for their mining operations.

The normal weight of the airplane was 2,300 pounds and that day Spisak was at 4,500. He came staggering in behind the power curve, a condition of extremely slow flight in which the drag of the airplane pushing through the air becomes greater than the lift it can produce. Behind the power curve it takes *more* power to go slower. There is no second chance under these conditions.

There was a creek just before the strip, so he couldn't land short without tearing off his landing gear. He knew that if he didn't hit the first 30 feet of runway, there was a good chance that he'd hit the cliff at the other end.

By the time he saw that the wind was blowing in the wrong direction, it was already too late. "I touched, bounced, then railed it and pulled the lever to dump the load of fuel," said Spisak. "Those two guys were standing there waiting for me, and I douched them with 270 gallons of diesel." Of course, without the weight and at full power, the AgTruck shot straight up like a rocket. "Since the ceiling was only a thousand feet overcast," he continued, "I immediately found myself in the clouds at about 6,500 feet. All I had was a turn-and-bank indicator and a compass—no instruments, no approach plates, nothing. Well, I knew it was 35 minutes back to Kotzebue, so I turned to my heading and timed it. I descended where I thought Kotzebue ought to be and broke out at 400 feet over the open ocean. There was no land anywhere in any direction." With more tailwind than he'd anticipated, he had passed Kotzebue and flown 40 miles out over the ocean toward Russia. He had no way of knowing precisely where he was, but he picked a compass direction out of a hat and finally made it back to Kotzebue.

After he finished his story, Spisak took the controls for the landing at Barrow. The windshield went all Christmasy as ice spun about the airplane. We broke out at 1,600 feet over frozen tundra and slid onto the runway so smoothly that I hardly felt the commotion of the wheels on the gravel.

It was 15 below zero when Spisak leaped out of the cargo door and dashed across the ramp. Cope and I fetched the ladder out of the cargo hold and put the engine covers on to keep the oil warm. We left the Barrow ground crew to load the DC-3 with more cargo and walked across a gravel expanse to eat at a Japanese restaurant there on the edge of the Arctic Ocean.

Dave Leonard refuels a Super Cub by standing on the over-sized and under-inflated tires that enable it to land on rough terrain.

After we ate, we got back in the airplane and headed out for Peard Bay, where the wind was blowing whitecaps. We flew at 1,000 feet over the ocean. Despite our distance from civilization, the beach was littered with 55-gallon drums from sea traffic. Spisak let down to wave-top level, roaring along at 185 mph. An ancient wrecked whaler, an abandoned fishing shack, and bleached deadwood trees from Asian continents passed beneath our wings.

We dropped cargo—1,000 pounds of pipe fittings—at Wainwright. It was another boardwalk community that looked as if it could be dismantled in an afternoon, warrens of beaverboard and galvanized steel, littered with the trash of unceasing construction: sheet metal, Tyvek, and nailgun ammunition.

At Point Lay I saw what looked like a spaceship that had just landed, bright and new and geodesic, surrounded by pale green house trailers coupled into rows of offices behind razor wire. It was part of the Distant Early Warning line, a series of radar stations set up across the top of North America to give advance warning of an enemy attack by aircraft or missiles from the north. People riding on ATVs would come out to the airplane and holler their requests into the wind. "Anything for CTS Construction?" Spisak shook his head, and the man in the yellow construction worker's parka flipped the motorcycle throttle and was gone. It's the last frontier, like the license plates say, but they're building it so fast that it won't be for long. The license plates ought to say "Alaska: Hardhat Area."

We were done unloading cargo for the day, and when Spisak got ready to take off, I crawled back into the empty bay for the ride home. At 2,800 feet we burst into bright sunshine, and I sat on a cardboard scrap on the cold floor, feeling the rumbling. The doors barely fit

anymore. I could see the white whistling world out there and feel the bitter cold. Wind whipped the bungees and cargo straps, hanging empty now.

Heading back at 9,500 feet I could see the Brooks Range gutting the cloud bank 50 miles ahead. As we came over the range we encountered a large and perfectly formed lenticular cloud, a signal of wrecking-ball winds, and in a few minutes we were being kicked around the sky. The clouds broke up below. A huge valley opened up. More hills appeared. Then tundra once again. We had crossed the Brooks Range twice today.

A black braided ponytail hung down his back past his waist. With his never-shaved beard and a little gray creeping in, Matt Owen, 38, looked like a real mountain man, the way most men that I met looked after only a short time in this country. A few days earlier, Owen had inserted a friend of Mike Spisak's, a bush pilot named Glen Earls, into the Brooks Range to hunt caribou, and now Owen wanted to go see if Earls was ready to come out. Owen would drop me, and I'd stay with Earls and help him clean up his campsite.

Owen was supposedly one of Mike Spisak's pilots at Alaska Island Air, but he owned his own Super Cub, and it didn't seem as if he did in fact work for Spisak. Yet Owen worked out of Spisak's offices. He was there every morning drinking Spisak's coffee. I asked more than once how this arrangement worked, but no one could quite describe the contract between Spisak and his various pilots. No bush pilot wants to admit that he works for another man. Everyone has to be his own boss, an independent. They all just help one another out because that's the way it's done here. Everything is voluntary or it just doesn't happen.

Owen and I took off into a sky that looked like wet concrete. We crossed the Hotham Inlet at 200 feet to watch flocks of trumpeter swans lift at the sound of our clatter and drift away over the mud flats. As we followed the jade course of the Noatak River, huge flocks of Canada geese flew south in elongated chevrons. Half-moon gravel bars slipped beneath our wings. We spanned a forest of gaunt pines.

Soon we began to see herds of caribou: dozens, scores, and eventually hundreds, flowing over the land as unstoppable as the course of the river itself. Owen circled the Cub lower still, turning a wingtip on the tundra, then dove and climbed away. A blond bear escorted her three cubs through a clearing. Her rolling motion and the great hump on her back unmistakably identified her as an Arctic grizzly. As we passed over at 100 feet, she reared up and undertook to strike us out of the sky with her enormous paw. Stories passed among bush pilots tell of grizzlies taking down Cubs that had flown too low. Certainly they are capable of it. Owen's airplane, always bloody from caribou and moose meat, has been attacked by bears in the wild.

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"There's no money in being a bush pilot," says Glen Earls, who came to Alaska from North Carolina. "Very few people can make it." Nonetheless, airplanes are a way of life in Alaska, which has six times more pilots per capita than the rest of the United States.

We pressed on into the mountains upriver, crossing the Nana region, where only 6,000 Inupiaq Eskimos live in an area the size of Kansas. Numerous white stone hills with flat tops of broken rock dotted the area. With no intercom, Owen had to yell above the engine noise. "You can land on any of those!" he shouted to me. "Problem is getting off again!"

We came upon two toppled caribou, and in between, running and waving at us, was Glen Earls, a stout and jolly man with a round head and an empty green pack frame jerking up and down on his back. We circled. Flying in what seemed like slow motion, Owen was approaching a sheer wall of rock when a downward burst of wind shoved us below the cliffside. He yanked the flap handle for an extra inch or two of lift, added full power, and climbed smoothly away. As we went around for a second try, he called back at me, "You only make one bad landing up here."

Earls was still running and waving as we came in for the next pass. Owen approached with the heel brakes already partially depressed for immediate traction. He dumped the flaps a second before touchdown, then applied hard braking once the wheels were firmly on. There was no rollout to speak of. We scraped in on a dust cloud of our own making and the little airplane jerked to a halt. Owen had already cut the engine and stepped out before I knew what was happening. In the unexpected silence that followed, little bits of shale grit could be heard falling on the fabric of the airplane.

I grabbed a structural tube above me and hauled myself out of the back seat to take a look. We had landed sideways on the long ridge, owing to the wind pouring over the top. The temperature

was in the 40s. A pale sun was out. I looked over the sheer sides and wondered how we would ever get off.

Owen hiked up his pants, his shirt open to reveal his red long johns, and admired one of the caribou that Earls had already dressed and beheaded. He tilted back his baseball cap, examining the antlers. "That'll go 410 [dollars] I'll bet you anything," said Owen. "You'll want that mounted."

From his once-white jogging shoes to a smear across the bridge of his nose that looked like war paint, Earls was covered with blood.

I studied the elk. The old bull had been migrating to the south across the valley floor when he was detained by a 180-grain 300-magnum round. Now Earls considered memorializing it in his basement.

Earls had crudely quartered three other caribou and put them in game bags, and we loaded the Cub with bloody cheesecloth bags. Then Earls and I stood on the lonely crag and watched Owen take off in a smoking clatter of pebbles. The little airplane with the big tires sank out of sight: it seemed to shoot off the cliffside in a cloud of dust, then succumb to gravity, only to catch itself at the last moment and surge upward once more as it gained flying speed, clawing the air.

When the noise had died away to a faint racket and the tremendous silence of the Arctic had descended on us once again, Earls and I hiked down the ridge and set to work on the carcass farthest from the camp. He lay his sawed-off shotgun beside us. The ridge on which we worked, a heap of shattered shale 3,000 feet long, fell away abruptly to an immense valley of forest and yellow tundra cut by tangled rivers that looped and spliced in coils of pewter.

Soon we had the animal apart. I had never cut up an animal before, but my squeamishness quickly turned to fascination with how marvelously the thing was put together. This was a work of nature, as was everything I could see for a hundred miles around, and everything beyond that for three or four hundred more. I was suddenly awed by our audacity in injecting ourselves into nature with such a tiny thing as an airplane. The scale was completely off the charts—the scale of size but also the scale of sophistication. The machinations of our civilization seemed like crude conceits compared with the caribou. I was overwhelmed with wonder at the strength and sentience built into this hooved being for survival in these Arctic reaches, for navigation across this continent with nothing but his eyes and nose to guide his thunderous locomotion. I wrecked it all in half an hour with a four-inch knife blade.

On a hunt, bush pilot Matt Owen peers through binoculars while girlfriend Linda Lowder tries to keep warm (above). Getting in for hunting is often easier than getting out again (right). To find the game, bush pilots rely on dependable aircraft like a Cessna 185 with wheel-skis (opposite).

Glen Earls and I cut up two caribou that afternoon and hauled the meat up to the top of the hill, carrying guns to use against the grizzlies that would sooner or later arrive. Then we sat in the lee of the tent to get out of the hectic wind and ate ham sandwiches, spreading mayonnaise on Roman Meal bread with a hunting knife. Earls reminisced about his days as a coal miner back in North Carolina, working 30-inch shafts deep in the earth. Learning to fly and becoming a bush pilot, he said, was "the dumbest thing I ever did." He was making $100,000 a year as a coal miner, which was how he paid for flying lessons. "There's no money in being a bush pilot," he said sadly. "Very few people can make it." Retired from bush piloting, Earls now works for the Aircraft Owners and Pilots Association in Anchorage.

As dusk approached we heard the far-off buzzing of an airplane and saw Spisak's Cessna 185 beating a course toward us. He circled several times, passing low to inspect the landing area before finally settling and skidding to a stop. When he stepped out, I asked,

"How do you like the new landing strip?"

"I'm here," he said. Earls and I loaded meat into the airplane while Spisak walked the runway, inspecting its ruts, bumps, and "widow makers," pieces of rock that could slash a tire. When he returned he glanced at the remaining meat and said, "What about all this?"

Earls said he didn't want the airplane to be too heavy.

Spisak hefted a leg of caribou and started throwing it in. "Heavy's not the problem," he said, and we loaded all the rest. I recalled him telling me that his rule of thumb was a pound to a pound and a half per foot of runway. "Six hundred-foot runway means you can take 800 pounds. Roughly. With wind you can take more." I also recalled Owen telling me that a half-dozen bush pilot acquaintances had died in the past year in crashes. Now the four-seat Cessna was loaded with five caribou, three men, and camping gear, and I had to wonder which would be more dangerous: getting in the airplane or remaining here overnight. I'd been a pilot for 15 years and had never heard of the sort of weight-and-balance calculation Spisak used. The truth is, up here, there's no balance, only weight.

Spisak cranked the engine and it bawled and clamored, scattering gravel behind us, and we set off down the desolate mountain ridge with clone suns (an artifact of ice fog) hanging pale and woeful on the ridge. I was in the back seat with the bloody bags of meat, which fell heavily against me like drunks. We

were fast approaching a wall of rock that rose, sheer and white, before us when Spisak yanked the lever for full flaps and eased back on the yoke. We lifted, bounced once, and with the stall horn blaring, made a sharp right turn and ran off the cliff still throwing gravel. We fell toward the black spikes of pine forest while Spisak cranked the trim wheel like mad.

We crawled across the treetops at 50 feet. If there had been an interstate to fly over, we would have triggered a speed trap. As soon as it became clear that we were not going to be impaled on the pines—one pilot in an identical airplane recently died that way—Spisak's grim features broke into a smirk, and then he and Earls burst into uncontrollable laughter.

This then is how it happens. As I sat and watched the twilight reflecting off white banks of riverstone, I fell in love with the moment. I saw my life back home as pain and chaos and futility and this as perfect clarity—the peace I'd always sought. I now understood the lure of this place and the strange ways people behave in it. It's not bravery or sport that takes one overloaded into a 300-foot dog-leg gravel bar on a river bank. Only a cornered animal fights this hard. But perhaps it's a final despair that can't be whipped. Or perhaps it's the only way to know what the wolf feels.

We crossed gleaming ash-gray mud flats cut with filigree intricacy. Undulating flocks of birds made oblique angles to our course. A ruptured and abandoned skiff appeared in a distant channel. Soon the squirming lights of Kotzebue wheeled into view and turned as we turned, like a carnival ride stranded on this shabby spit of land.

Late that night, Matt Owen and his girlfriend Linda Lowder, a researcher from the Department of Fish and Wildlife, and Dave Leonard, 37, Owen's alter-ego pilot, sat in the office drinking beer. Twenty years earlier, in high school back in the Lower 48, Leonard and his best friend Danny Cowan had read Jack London and Robert Service and dreamed of Arctic adventures. In 1974, between junior and senior years in high school, Danny and Dave visited Alaska for the first time, and the next year, 1975, they stayed. They hired on as packers, camp jacks, for an old master guide who still used horses. They were 17 years old.

From packer to assistant guide to registered guide they worked their way up, and as soon as they could, they learned to fly. Leonard acquired his guide certificate in 1981, and five years later he was finally able to buy his own Super Cub, from a pilot in trouble with the IRS. Shortly afterward Danny Cowan was killed in a crash. It was difficult for Leonard to go back to flying after that. "I thought Danny was invincible," he said.

Dave Leonard and Matt Owen got together in 1989, hobo ministers of such marginal pursuits as can exist only in storybooks and in this raw, disordered province. They have been laboring side by side ever since. Sentinels against happenstance, they live by reading the wind and by walking the ridges and gravel bars looking for that singular stone, that rift in the land, the white driftwood spar camouflaged on white stone that would end it all.

I came to know their furtive, nervous, outlaw comportment, the sidelong exchange of surreptitious glances, when in first light, with hands cupped around steaming mugs of coffee, they stepped out onto the ramp amid pallets piled high with meat crates and moose antlers to inspect their Cubs, waiting side by side like two old wolves.

And each night they drank their beer and told stories with the airplanes they made of their hands. "There we were, coming in overloaded, *way* behind the power curve, full flaps...." Or: "We was coming onto that one old stretch of the Kugururok and man, it was blowing, I mean it was just *howling*...."

Why did they keep going out? I knew now, I knew. And I longed to stay in that landscape, because here the feeling of being lost and the fact of being lost were one, while at home the feeling was merely a confounding contradiction, a character flaw, a personality disorder. I understood how a bush pilot came to be, came to set himself out here and make himself poor and doomed to work so hard every day. For he is a passionate and ultimately lonely man who, living an ordinary life back in the world, knew that a grizzly bear was eating him alive. He just couldn't see it. Now he has come to a place where a grizzly bear really might eat him alive. But it's all right, because he can see it. Each morning here he rises to greet a vast landscape that stretches away like the restless dream of a poet. And in a life where nothing ever felt authentic, this finally feels right. This place was in his heart, and so he brought his heart to this place.

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THE LATEST WORD ON TOURS, EXPEDITIONS AND LEARNING ADVENTURES

In the 1950s, kids across America stayed glued to their TVs as Tom Corbett and his pals Roger and Astro blasted off on another 24th century adventure.

by Frank Kuznik

When I was growing up, there was nothing I wanted more than to be a Space Cadet. Silly as it may sound now, that was the dream of every young aspiring spacefarer who sat in front of a television in the early 1950s.

In those years, the seminal space hero of the new medium was Tom Corbett, Space Cadet, the star pupil at Space Academy, U.S.A., the West Point of the 24th century. Zooming off on adventure after adventure with two fellow cadets aboard the rocket cruiser *Polaris*, Tom epitomized—in the words of the booming voice-over that opened each installment of the show—"the age of the conquest of space...the world beyond tomorrow!"

"Tom Corbett, Space Cadet" proved so popular it soon expanded into radio, comic books, and a wonderful series of novels that I read over and over again. Filled with sleek silver rockets, menacing space pirates, and primitive planets populated with dinosaurs, they thrilled kids with passages like: "Once again, Tom Corbett sat at the controls of the *Polaris*, heading into an unknown sector of the universe with the threat of danger riding in his wake.... The curly-haired cadet remembered childhood dreams of doing just what he was doing at this moment, preparing to touch down on a new world, millions of miles away from his home near New Chicago."

In the 1950s, this seemed more than a mere childish fantasy. Recent wartime victories had invigorated our nation's faith in aerospace technology, and we were taking the first steps toward mastering the practicalities of space travel. The U.S. military had brought Wernher von Braun and his fellow German engineers to America so we could learn the secrets of their V-2 rocket and embark on a development program that would eventually produce the Redstone, Jupiter, and Saturn launchers. Just a year before Tom Corbett appeared, the United States had launched the first rocket into outer space: a WAC-Corporal atop a V-2 that reached an altitude of 244 miles.

Debuting on CBS in October 1950, Tom Corbett served as a herald of the new era. He wasn't the first space travel-

Years before Kirk, Spock, and McCoy beamed onto the airwaves, young TV viewers avidly followed the story of another spacefaring triumvirate—Roger Manning, Tom Corbett, and Astro (left to right). "Tom Corbett, Space Cadet" proved so successful it spawned a vigorous spinoff industry, which offered everything from sew-on patches to comic books and adventure novels.

MEMORABILIA AND BLACK & WHITE PHOTOS COURTESY WADE WILLIAMS

The Original SPACE CADET

Tom Corbett was a pioneering series. The director, George Gould, devised a way to substitute backgrounds that enabled him to create scenes like the one above, in which characters temporarily deprived of the effects of the "artificial gravity" machine appeared to float through their spaceship. The show also featured a trailblazing female character, Dr. Joan Dale, who was a scientist rather than a mom (opposite, top).

er in American pop culture: "Captain Video" had appeared on television a year earlier (though the initial episodes did not take place in space), and "Buck Rogers" had been a radio and comic strip mega-star back in the 1930s. But in its touches of scientific realism, Tom Corbett was unique. "Other shows had talked about space, but this was the first one that actually got rockets off the ground with people in them and presumed to travel to planets that we knew, like Mars and Venus," says George Gould, who served as the show's first director.

"Our stories are not in the realm of fantasy," producer Allen Ducovny insisted to a writer who reported on the show in a 1952 *New Yorker* story. "No disintegrator rays. No mad scientists. No lobster men from Neptune. It is our policy to show the process of interplanetary travel, and the conditions on the planets we travel to, as accurately as science can today.

"In the last few years youngsters have become pretty well aware of what science can do and what it can't do, so they're fairly critical on technical grounds of electronic razzle-dazzle in stories," Ducovny added. "Kids will accept only so much of that nowadays."

To give young viewers the overlay of authenticity they craved, the producers hired a technical advisor, German Rocket Society founder Willy Ley. A close friend of Wernher von Braun, Ley was the Carl Sagan of his day, having authored two influential books for laymen, *Rockets: The Future of Travel Beyond the Stratosphere* and *The Conquest of Space*, both of which preached the gospel of manned spaceflight.

Ley's influence on the Tom Corbett craze was pervasive. He even supervised the design of some of the toys. During a script conference recounted in the *New Yorker* piece, Ley fielded a variety of questions with striking aplomb that sometimes verged on arrogance.

First the scriptwriters told him they needed a new planet resembling Earth in prehistoric times. "I suggest you place it within the solar system of Alpha Centauri," Ley said, "which is comparatively close to our own solar system."

"Willy will triangulate the position of the planet for you later," the script supervisor assured the writers.

"Anything special in the way of supplies?" one of them asked.

"Apart from the usual oxygen masks, and so on, I suggest you provide the crew with a good supply of pemmican [dried meat]," Ley replied. "Cakes of soap will do the trick. They look like the real thing. Incidentally, I wouldn't use food pills. Some other space show has been feeding its crew food pills, and anyway they couldn't possibly work. The average man needs at least two pounds of starches and proteins per twenty-four-hour period."

"How far is this Alpha Centauri, again?" Gould asked.

"Four and a third light-years," Ley told him.

"I was just wondering—isn't it true that the speed of light is the fastest you can go, even theoretically?"

Ley brushed the objection aside. "That theory has been punctured time and again, and is self-contradictory," he declared. He went on to concede: "We'll be obliged to take some liberties with the time factor, of course. Maybe the best way to handle the problem of just how long it would take to reach the planet would be to pretty much ignore the time factor [and] just equip the space ship with something we might call Hyper-drive, and let it go at that."

Ley's advice exemplifies Tom Corbett's amusing mix of fantasy and fact—or what passed as fact in those years. The show avoids the most obvious and oft-repeated mistake concerning TV spaceships—How come there's gravity?—by having the cadets switch on an "artificial gravity" generator after takeoff. (In one show the generator was accidentally turned off, sending the crew "floating" through the craft. The effect was achieved by filming the actors against a black background, then inserting just the images of the actors into footage of the craft.) And the Tom Corbett books also include some believable scientific details. At one point in *Danger in Deep Space*, Commander "Blast-Off" Connel tells the crew: "The Moon is a captive satellite of Earth, revolving around Earth the same way Earth revolves around the sun. It's the same situation we have here. This satellite is a captive of [fictitious planet] Tara, and Tara is a captive of Alpha Centauri. The difference is that the satellite is a peanut compared in size to the Moon, being only about fifteen miles in diameter. I'm not sure, but I think I can get enough reactant energy out of the *Space Devil*'s fuel supply to blast the satellite out of Tara's grip and send it back to our solar system in one piece!"

Then again, some technical details seem amusingly naive today. The same book has Tom protecting his ship from thieves by simply removing the "master switch" and hiding it under the pilot's seat. And in *The Revolt on Venus*, after a saboteur's bomb damages the *Polaris*, fellow cadet Roger Manning assures his commanding officer: "The radar deck can be patched up easy. With some new tubes and a few rolls of wire I could have her back in shape in no time."

Of course, 45 years ago no one knew much better—least of all junior space cadets transfixed in front of the television, itself a marvel of new technology. "Watching Tom Corbett was a very impressionable thing when you were 10 years old," recalled the late Tom Scherman, a Hollywood special effects veteran. "I actually believed, up to about the age of 13 or 14, that I would be able to build a spaceship. I think every kid wanted to do that in their backyard or basement."

That belief was bolstered by some savvy kid-oriented merchandising. Space-theme marketing was everywhere, some

BRAD TRENT

After working on Tom Corbett, George Gould went on to become a director and producer for CBS. Today he enjoys passing time with his three goats, two huskies, and pet llama.

based on Tom Corbett, some simply on the space fervor that had seized the country. Nearly 200 Space Cadet toys were manufactured, ranging from patches and pins to a full-blown Space Academy playset complete with figurines and rockets. "Schwinn came out with an aerodynamic bicycle with bumpers shaped like rocket fins," says Christine Roman, who oversees the Space and Popular Culture gallery at the St. Louis Science Center in Missouri. "There were cookbooks that had space themes and space treats for kids' birthday parties, stuff like space burgers and satellite cherry tomatoes." The film industry also capitalized on the space theme. "Kids were encouraged to come to movie theaters in costumes, and there were all kinds of activities you could do at home related to space," Roman says. "Sometimes [theater owners] made rockets to put on display outside the theater."

Its producers liked to boast that Tom Corbett offered kids scientifically credible entertainment, but the show ended up having another, less lofty purpose: moving merchandise. Cast member appearances at various stores helped keep kids clamoring for the nearly 200 Tom Corbett-related products marketed.

Not surprisingly, it was spacemen who drew the most fans. During the 1951 Christmas shopping season, the Tom Corbett cast made an appearance at Gimbel's department store in New York City and attracted 6,000 kids in a single day. Frank Thomas, the actor who portrayed Tom Corbett, remembers a promotional visit to a junior high school in Brooklyn: "We got there when they were doing their annual class production: 'Tom Corbett on Mars!' " he says. "The mothers had been busy sewing away, because all these kids had space costumes. And when the Martian army appeared on stage, I mean, you had a lot of kids. I remember the producer saying, 'Jeez, if there was only some way we could get them on the show'—because our armies were mostly off-stage."

By today's standards, the casting of the show was absurdly thin. In one episode pitting the cadets against invaders from Mercury, the Mercurians wore face masks—so no one would notice that they were played by the same actors portraying the heroes. In some shows, the cast members had to do commercials as well ("Kraft caramels—they taste swell, and they're good for you too"). But the series did have enough secondary roles to offer young actors some occasional work: Tom Poston ("Newhart"), Jack Lord ("Hawaii Five-0"), and Jack Klugman ("The Odd Couple") all made appearances.

As for the main character, he was lifted from Robert Heinlein's 1948 novel *Space Cadet*, though few of the book's details made it into the TV series. The neophyte protagonist was transformed into a take-charge leader flanked by two trusty sidekicks—essentially the same configuration "Star Trek" employed years later. Tom Corbett was the intrepid hero, Roger Manning was a bit of a smart aleck, and Astro, a Venusian, was a quieter, dependable sort.

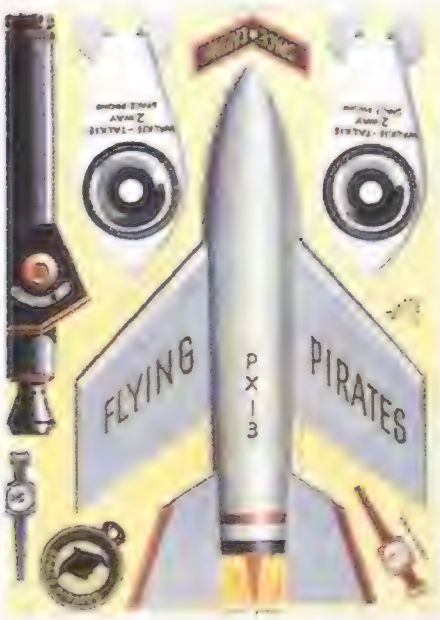
Jan Merlin, 25 and fresh from the Broadway stage, inadvertently gave Roger Manning his caustic edge when he forgot his lines one day. The cadets were arguing over how best to rescue an officer cast adrift in space when Roger insisted they return to Space Academy for help. "I had all these fabulous reasons for doing it that way, very technical-type things involving all that space jargon I always had a hell of a time remembering," Merlin says. "Astro said to me, 'Do you mean to say you'd leave Captain Strong out there to die?' And I looked at him, and I couldn't remember a line—nothing. So I said, 'Why not?' From that time on Roger became a real smartass.

"The kids adored him, because he always got into trouble," Merlin recalls. "They used to follow me home on the subways of New York.... Sometimes on Sunday I'd be sleeping and I'd hear these little giggles and knocking on my apartment door."

Al Markim, a 23-year-old actor, played Astro, sort of a predecessor to Mr. Spock in his alien status. "They wanted me to create a Venusian," he says. "Not like we have today—people with big growths on their faces—but a character that would represent perhaps the kind of people who would come from another planet in our solar system after several hundred years of colonization by Earth.

"When we did personal appearances, I became very aware of the disproportionate number of black children who would come to me for an autograph," he says. "I was different—in some of the scripts they even made fun of me because I was from Venus, and the black kids identified with that."

Like most other series of the time, "Tom Corbett" did not include black characters, but it did include a woman, Dr.



PHOTOGRAPHY, RECORDS AND CUTOUTS
TERRY McCREA, MIDGE RUE, KEVIN LOWDER
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Joan Dale, whose expertise in astrophysics struck a surprisingly progressive note (she was the one who invented the aforementioned Hyper-drive).

Other television shows that used a space setting began to appear, such as "Rocky Jones, Space Ranger," "Johnny Jupiter," and "Rod Brown of the Rocket Rangers" (which Tom Corbett director George Gould left to work on). Few had Tom Corbett's staying power. But finally, in 1955, the show came to an end.

For Frank Thomas, who had been acting since he was 11 years old, "the Tom Corbett role was certainly one of the highlights of my career. You don't often get a show that does that well commercially and sort of lasts in people's minds. What more can you ask?" Thomas is also proud of the show's prescience. In a reminiscence he penned for *Filmfax* magazine, Thomas noted: "When I saw the astronauts take that giant step and walk out on the moon, their space regalia bore a remarkable resemblance to the outfits we wore on the show when operating in free fall and on strange planetary surfaces."

Thomas went on to become an expert bridge player, instructor, and commentator. More recently he turned to mystery writing, appropriating the Sherlock Holmes character and making him a master card player.

Al Markim continued to act for a short period after the Tom Corbett show, then teamed up with one-time Corbett director George Gould to run a television production center in New York. Later, Markim moved into movie production. More recently he ran a TV syndication company and a video distribution business. He retired about a year and a half ago and now lives in suburban New York. "To this day," he says, "almost anytime I meet people in a new situation, they'll ask, 'What did you do?' And if Tom Corbett comes up, someone will inevitably say, 'Oh, that was my favorite show.' "

Rather than serve up confections of pure space fantasy, Tom Corbett featured lessons in real science (right) and a strong ensemble of distinctive characters. In the comic strip block below, Roger displays his typically caustic wit.

Spacetalk

In the world of Tom Corbett, space was more than a destination—it was a frame of mind, a cultural milieu. Cadets followed the spaceman's code, played space ball, and wore uniforms made of space cloth. They had an admiring eye for space dolls, and when it was time to go on a mission they packed their space bags.

Villains were space creeps, space rats, or space crawlers. When they drank too much space juice, they'd get space happy. Inevitably the *Polaris* crew had to chase after them at full space speed, and sometimes even use space torpedoes. But with a little spaceman's luck, our heroes always prevailed.

Though the show was aimed at kids, within weeks of its debut disc jockeys and comedians were using spaced-out terms and phrases from the Tom Corbett lexicon, including:

(the standard 24th century opening line)
—What's the latest space dope?

(all-purpose exclamations)
—By the rings of Saturn!
—Blast me for a Martian mouse!
—Spaceman's luck!

(smart remarks)
—Don't give me that meteor dust.
—Lay off that space gas.
—You're way off your orbit.
—What are you fusing your tubes about?
—Go blast your jets.
—Why don't you go to Saturn and play ring around the planet?

In 1993 a group of old-radio fans got the crew and director together to re-create an original Tom Corbett broadcast (below, left to right: Al Markim, Frank Thomas, George Gould, and Jan Merlin). Today, the three actors are retired from show business.

COURTESY JAN MERLIN

Jan Merlin left the show before it ended, tiring of the Roger Manning character. "I'd really had it, really wanted to get away," he says. "I had a feeling that if I stayed with it, I would forever be typed as a space cadet, as somebody in a kid's show." A new character was substituted. Merlin eventually moved to Hollywood and became a character actor in both movies and television, more often than not playing the bad guy ("I was always killing somebody or being killed," he says). He wrote TV scripts for a while, winning an Emmy in 1975 for his work on the soap opera "Another World." When Merlin goes to film festivals today, "invariably I will be accosted by people who grab me and say, 'You're Roger Manning'.... Some of them even know lines from the show."

The trio was reunited for the first time in nearly 40 years in late 1993, when they were asked to re-create a Tom Corbett radio broadcast for a convention held by a group called Friends of Old Time Radio. The three actors, who had done both the television and radio shows, journeyed to New Jersey to perform one of the original episodes. "We had a marvelous time, absolutely marvelous," says Merlin. "The moment we began to read the lines in rehearsal, it was as though no time had passed. Suddenly the voices were the same, and the readings were the same, and the attitudes were the same. It was as if it was yesterday."

As I took another look at the old shows and read over those great books recently, I had much the same feeling. Despite 35 years of real manned spaceflight, much of it now thoroughly routine, the adventures of Tom, Roger, and Astro seemed as thrilling as ever. And as inspiring—after all, no matter how bad a fix they got in, there was nothing the trio couldn't solve with a little basic physics, a few vacuum tubes, and a couple of rolls of wire.

CHAD SLATTERY ©

>SIGHTINGS<

NASA

Cosmonaut Valeriy V. Polyakov peers from a window of the Russian space station Mir to watch the approach of another space vehicle: the U.S. shuttle *Discovery*. On February 6 the shuttle maneuvered to within 37 feet of Polyakov's orbiting home in a practice run for a shuttle-Mir docking planned for later this year. The Russians had feared that oxidizer leaking from one of *Discovery*'s thrusters could contaminate the station's solar panels or optical sensors on spacecraft already docked at Mir, but the close encounter went off without a hitch.

Another view of Mir from *Discovery* (above) shows a Soyuz spacecraft docked to the space station at the bottom of the image. At the top is one of the unmanned Progress ferries that resupply the station, which has been in orbit since 1986. Polyakov arrived on January 8, 1994. As this magazine went to press, he was scheduled to return to Earth on March 22, setting an endurance record of 438 days in space.

From Pearl Harbor to Tokyo Bay

Crossing the Line: A Bluejacket's World War II Odyssey *by Alvin Kernan. Naval Institute Press, 1994. 173 pp., b&w photos, $21.95 (hardcover).*

"War's cruelty and randomness, its indifference to human life and the speed with which it erases existence forces anyone who thinks to realize that war is not an aberration, only a speeded up version of how it always is." This astute observation, one of many in *Crossing the Line*, reminds us why war has produced some of the world's greatest literature. *Good-bye to All That*; *Goodbye, Darkness;* and *Fields of Fire* were all written by warriors who survived to pursue literary careers and who drew on their battle experiences to produce their finest books. Alvin Kernan, who has taught for many years at Yale and Princeton Universities, has written a memoir sure to be another such classic. His prose is polished, spare, direct. He recounts a wonderful and exciting American story about a poor farm boy from Wyoming who enlisted in the Navy because there was nothing to hold him at home.

Crossing the Line covers Kernan's service from boot camp at San Diego in March 1941 through discharge five years later, the recipient of many air medals and the Navy Cross. His first assignment was aboard the carrier *Enterprise*. "Unaware of what it meant to be a sailor in Honolulu, I tried to make a date with one of the beautiful [local] girls, only to learn that her father would rather see her date one of the lepers from Molokai than a sailor." By good luck the carriers were out of Pearl Harbor until the day after the Japanese attack. Kernan vividly describes the scene upon their return.

Kernan saw his first action in the Marshall Islands. At Midway his squadron lost nine out of 14 aircraft. He describes the end of the first day of fighting as the returning pilots waited to be debriefed: "These were heroes dressed in the khaki flight suits, carrying pistols and knives over their yellow Mae Wests, and describing with quick hands and excited voices how they had gone into their dives, released their bombs, and seen the Japanese flight decks open up in flames just below them. The slaves who carried the equipment of the Greek warriors at Salamas...could not have felt more envious or less heroic than I."

At the battle of Santa Cruz, Kernan survived the sinking of the *Hornet* by Japanese dive-bombers. Before long he was flying as an aerial gunner in torpedo planes from the *Nassau* and then the second *Lexington*. Kernan had many brushes with the grim reaper, including a bad catapult shot that crashed his Avenger into the sea: "The ship above us went tearing by. All I saw was Cletus Powell leaning out of a porthole in the parachute loft where I had just lost $75.00 to him, which I did not have, at blackjack, yelling, "Kernan you don't have to pay! Get out, get out, get out for God's sake!" On another mission his Avenger was hit by Japanese machine gun fire that severed the flight control cables. The crew was able to splice the cable just in time to land on the carrier. Kernan skillfully depicts the dangers aboard a carrier during war: "One day a plane would crash taking off...a thoughtless step backward on the flight and hangar decks where the planes were returning led to decapitation and gory dismemberment by propeller." Tragedy visited often: One airplane loaded with depth charges crashed in the water alongside the ship. "While we watched the crew swimming in the water," Kernan writes, "the depth charges exploded." What made such losses all the more painful was that the casualties were friends: "April 25th, Collura, Powell, to whom I still owed my blackjack losings, and Stewart were hit in a dive and went in and exploded; April 27th, Campbell, the commanding officer, Loughridge, my

NAVAL INSTITUTE COLLECTION

U.S. Navy TBF Avengers leave their carrier behind en route to combat in the Pacific.

close friend, and Zahn were hit and disintegrated in the air. Death had by then become familiar and almost unremarkable, but it still was difficult to accept that someone that you knew well and had played cards with in a normal way only a few hours earlier was now gone forever...." Part of this book's greatness lies in Kernan's ability to write about death: "My eyes moved from one face to another of men who are as alive to me now as they ever were but whose bones are washing around the bottom of the sea, tangled in the wreckage of their planes, between Okinawa and Taiwan, near islands with such romantic names as Ishigaki, Miyako, and Kerama-Retto."

Kernan's war came to an end when the bomb was dropped on Hiroshima and Nagasaki; "each of us felt those bombs had saved our lives, not lives in general, but our own felt, breathing lives." He went ashore at Nagasaki and saw the devastation: "I was grateful and unashamed."

Alvin Kernan has written eight other books. I will go back and read them all.

—John Lehman was Secretary of the Navy in the Reagan administration.

A Passion for Wings: Aviation and the Western Imagination, 1908–1918 *by Robert Wohl. Yale University Press, 1994. 320 pp., b&w photos and color illustrations, $35.00 (hardcover).*

"Wow!" That was my first comment on opening Robert Wohl's new book and discovering the rich feast of illustrations, which feature people, airplanes, sheet music, poetry, photos, cartoons, book illustrations, and much more. But reviews need to be calm and dispassionate. It was my charge to determine if the text merited the academic accolade "authoritative."

Wohl received the 1982 American Book Award for *The Generation of 1914*, which was written from his background as a scholar of European intellectual and cultural history. It was during the writing of this earlier work that he became aware of that era's fascination with flight; later he realized that aviation history seemed to be absent in "the main narrative of the twentieth-century West," and he became determined to rectify the problem. *A Passion for Wings* is presented as the first of three volumes intended to carry the saga up to the present.

Early chapters assess the work of Orville and Wilbur Wright in developing a successful powered airplane. The Wrights' sojourns in Europe and the Continent's response to them exemplify much of the paradoxes of Wohl's book. Public response to the Wrights (and others who had achieved the Promethean feat of flight) was emotional and romantic. Yet Wilbur was very precise and cautious about flying—not a larger-than-life aviator—and he quit in 1910. Throughout his book, Wohl explains that the popular conceptions about flight were one thing and the cold realities something else.

The author also does a marvelous job of analyzing pre-war fantasies about aviation and war, and includes a telling chapter on aces and their frequent preoccupation with official lists of their "kills," which belies the public's assumption that they conducted aerial jousts with chivalry. Other chapters dissect avant-garde literary responses to early aviation, including a fascinating essay by Franz Kafka, as well as the metaphors of flight in the modernist art of early 20th century Russia, France, and Italy. The artwork here and throughout the book is stunning. It is possible to sum up Wohl's book in two words: Wow. Authoritative.

—Roger Bilstein teaches history at the University of Houston-Clear Lake and is completing a history of the U.S. aerospace industry.

Commuter Airlines of the United States *by R.E.G. Davies and I.E. Quastler (foreword by George Haddaway). Smithsonian Institution Press, 1995. 480 pp., b&w photos, $56.00 (hardcover).*

Commuter airlines have been with us in one form or another since the dawn of commercial air transportation. Yet not until R.E.G. Davies, a National Air and Space Museum curator, and I.E. Quastler teamed up to produce this work have we had anything approaching a comprehensive history of the U.S. commuter industry. It is not a book you curl up with in bed; it is something you keep on your shelf to pull down when you are searching for facts.

Actually, Davies and Quastler have given us three books in one: a narrative history of the industry, profiles of 22 industry pioneers, and a tabular section mixed with narrative that catalogues every commuter line that ever took flight over North America, divided into 13 regions. The third section alone, brimming with detail, makes this work a worthwhile endeavor.

But it is not an endeavor without flaws. Readers with fond memories of Davies' previous work will doubtless approach this volume anticipating something sumptuous and insightful. They will not find it. The profiles are bland and uncritical, and events in the narrative section take place in a virtual vacuum. What context is established is narrow, limited to developments in aviation technology and changes in federal rules governing airline economics. Citations are nonexistent, and the bibliography is thin.

And there are oddities. None intrude more on the reader's consciousness than the appearance in the narrative of R.E.G. Davies himself, where we find him in 1966 touring the United States and holding forth on the commuter industry of the day.

Still, this book cannot be ignored. Davies and Quastler have mined and

SPECIAL INTEREST

A Wartime Log. *Text by Art Beltrone, photographs by Lee Beltrone. Howell Press, 1995. 208 pp., b&w and color photos and illustrations, $34.95 (hardcover).*

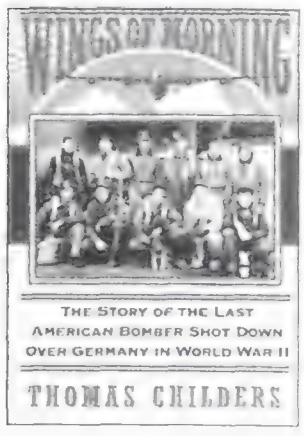
American prisoners of war in Germany during World War II—many of them aviators—were provided with blank books from the YMCA. Using inks extracted from food can labels and paintbrushes made from their own hair, many of these POWs created artwork. This compilation provides a compelling record of their time in captivity.

packed into one volume a rich ore of information. The result is the best source to date on the commuter airline industry.

—Nick Komons is an aviation historian and a contributing editor of Air and Space/Smithsonian.

Wings of Morning: The Story of the Last American Bomber Shot Down Over Germany in World War II *by Thomas Childers. Addison-Wesley, 1995. 288 pp., b&w photos, $23.00 (hardcover).*

In this account of a heavy-bomber crew of the Eighth Air Force in England, nothing about the people sets them apart from the thousands of airmen who populated the airfields of East Anglia between 1942 and 1945. Even considering the incident in which all but two of 12 men aboard the B-24 Liberator *Black Cat* lost their lives on the crew's 23rd mission, the circumstances were not extraordinary, despite the author's implication that the mission command pilot had issued a questionable order. That order, following bad weather over the primary target (Salzburg), directed the bombers to fly over what has been reported as a more heavily defended place—Regensburg. There the *Black Cat* was struck by flak and crashed. In combat, any order that leads to disaster could, in hindsight, be called questionable.



So, one may ask, why a book about these ordinary people engaged in ordinary wartime pursuits from one of 130 airfields in an area about the size of Delaware? Surely the fact that the *Black Cat* was the last Eighth Air Force bomber lost over Germany (on April 21, 1945, two weeks short of Germany's surrender) is only a footnote in the history of the war in Europe. The answer appears to be twofold. First, the author, a professor of history at the University of Pennsylvania, who has written three other books about Germany, is a nephew of one of the men who fought and died aboard the *Black Cat*. At least initially, it appears the book may have been intended simply as a memorial to Uncle Howard.

The second reason for the book is that Childers discovered that his uncle may not have died in the bomber's crash, as his family and others believed for nearly 50 years. The discovery came as Childers studied a file on all of the *Black Cat*'s missions at the Air Force Center for Historical Research at Maxwell Field in Montgomery, Alabama. It was known that two men bailed out of the crippled bomber, were taken prisoner, and survived the war. But the file on the *Black Cat* noted that a crew member of another bomber reported seeing four parachutes rather than two. Could one of the additional pair have carried Howard safely to the ground? Also, Childers received files on each of the *Black Cat*'s crew members from the Graves Registration Service in Washington, which suggested that Howard and one of his mates may have been victims of an atrocity.

Childers runs down those leads both in this country and in Germany, where he questioned villagers who were witnesses to events at the time of, and soon after, the crash. His investigation turns the book into something of a whodunit over the last 40 pages. Readers interested in the lore of the Eighth Air Force will enjoy this authentic story.

—Charles F. Kiley was a Stars and Stripes *correspondent who flew with a B-17 crew out of the 385th Bomb Group.*

The Airport: Terminal Nights and Runway Days at John F. Kennedy International *by James Kaplan. William Morrow, 1994. 278 pp., b&w photos, $23.00 (hardcover).*

Once upon a time airports were modern, shiny places where the filthy rich boarded gleaming jets and headed off to exotic locales. The rest of us would get in our cars and drive to this land of tomorrow for the privilege of dining at the posh airline-operated restaurant while we watched big new jets arrive and depart.

How times have changed. Now major airports are maligned places that we endure only to get somewhere else. To James Kaplan, a contributing editor for *New York* magazine, nothing symbolizes the decay in our once-promising society better than New York's overcrowded, crime-infested John F. Kennedy International Airport.

To get to the bottom of the place (and, by association, the ills of our modern culture), Kaplan spent several years lurking amidst the chaos of the terminals and the wilderness of the runways, an area roughly the size of Manhattan below 42nd street. While seeking answers he discovers a host of offbeat facts (the leading cause of death at JFK is the coronary; there's an average of one a day there), and he introduces us to a sampling of the airport's 44,000 employees. We meet disgruntled service workers and airport cops, a blasé airline pilot who is most concerned with the quickest highway routes to and from work, and a former helicopter pilot who lost his will to fly and now wanders the airport's perimeter like a lost soul.

Despite some self-conscious, hipper-than-thou passages, many wonderful, refreshing, sometimes black moments punctuate *Airport*, such as when Boy Scouts splattered with fake blood pretend to be crash victims during an emergency drill: "Perhaps because of my presence, a few of the other Scouts lying around on the runway have jumped the gun a little bit. 'Help me,' a couple of them groan. 'No, help *me*.' "

At times Kaplan's stylish prose reminds me of myself when I study a Chinese carryout menu: Ahh, chicken dumplings! Ahh, egg rolls! Kaplan spends a lot of time gasping at some pretty prosaic things—Ahh, navigational equipment! Ahh, abandoned airport buildings! But sometimes egg rolls can hit the spot, and likewise, sometimes so does *The Airport*.

—Phil Scott is the author of The Shoulders of Giants: A History of Human Flight to 1919 *(Addison-Wesley).*

FYI

The Flying Pig Airliner Catalogue features postcards, videos, books, artwork, models, and other products related to airlines. To order, include two first-class stamps and write: Flying Pig Airline Products, P.O. Box 69, Kingston, MA 02364; or call (617) 585-5796.

The Secret Story of the Soviet Space Shuttle *by Henry Matthews. X-Planes Book 1 (131 Alameda Ave., Fircrest, WA 98466), 1994. 100 pp., color and b&w photos. $19.95 (paperback).*

With so much attention given to the future international space station, there has been little energy left for a new look at past Soviet space activities. This is a pity, because new material of tremendous historical interest continues to filter out.

This book is a fine example. It bills itself as "the first full account of the development and construction of the Soviet space shuttle," of which the Buran was only the last chapter. And the author, an amateur analyst, delivers on the promise. The credits on many of his photographs show he has a good relationship with the Videocosmos group in Moscow, probably the best source of space information in Russia.

The narrative provides some interesting background on Soviet spaceplane projects, then describes in

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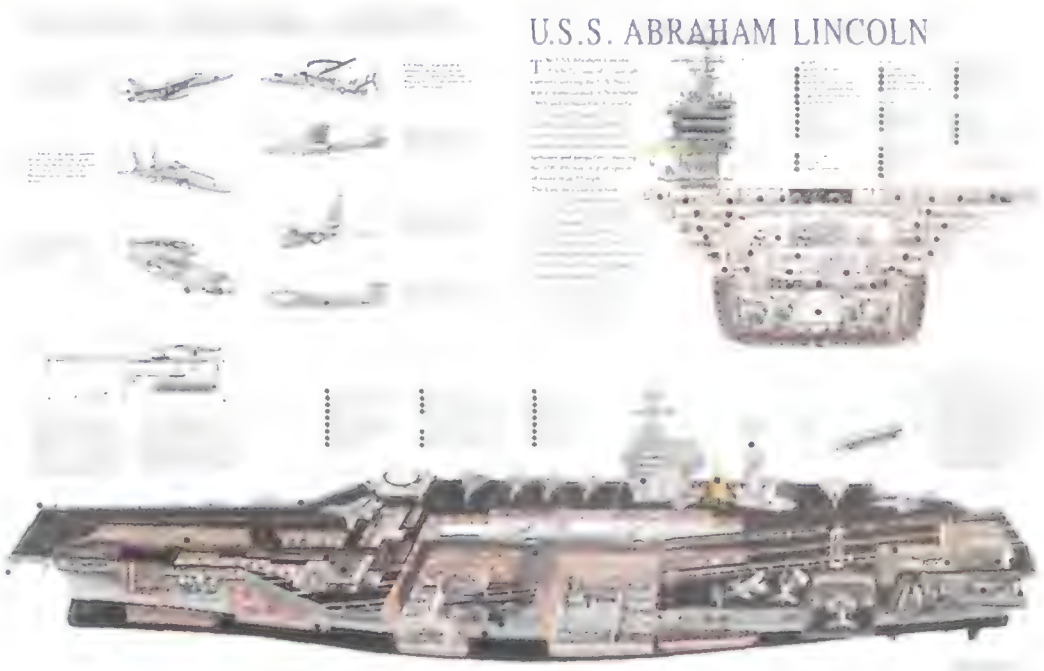

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astonishing detail the test flights of various Buran prototypes and precursors. Much absolutely new information on the test pilots is provided.

Henry Matthews has done a creditable job of sifting the conflicting material, picking out and organizing what is significant, and reconciling contradictions and gaps. Two errors that caught my attention show the price paid for working independently. Matthews says that the Buran "analog" jet-powered flight tests were conducted at the Jubilee Airfield at Baikonur, when they actually occurred at the Ramenskoye test facility southeast of Moscow (he more than makes up for this by listing each test flight, by date, crew, and mission). The author also accepted the widespread but subsequently abandoned theory that the mysterious "twin payload" Proton flights of 1976 to 1978 deployed two spaceplanes mounted belly to belly (we now know from memoirs that these were tests of the Chelomey Bureau's three-man "Merkur" capsule for use with its later canceled military space station).

This book is privately printed and distributed, and at $19.95 is a bit pricey for a 100-page paperback. But the production quality is excellent, with a few good color views and numerous good black-and-white illustrations, many of them never seen before. For the space history buff, this is a "must buy."

—James Oberg is a contributing editor of Air & Space/Smithsonian *and author of* Red Star in Orbit *(Random House, 1981).*

Hindenburg: Reliving the Era of the Great Airships (An Illustrated History) *by Rick Archbold. Paintings by Ken Marschall. Warner Books, 1995. 229 pp., color and b&w photos and illustrations. $60.00 (hardcover).*

This is not, as the title suggests, a picture history of the short, ill-fated career of the LZ-129. Rather, it is the ultimate coffee table book on the rigid airship. I mean nothing pejorative by that term. The folks at Time-Warner have taken full advantage of the large-format pages to present a richly illustrated history that carries readers from the work of 18th and 19th century dreamers to the latest schemes for reviving the big rigids.

Rick Archbold's text provides a solid and comprehensive overview of the subject. Aficionados will find few errors here. Sidebars and other special features focus on topics ranging from leading

engineers and airship captains to a minute-by-minute analysis of the movements of the *Shenandoah*, *Akron*, and *Hindenburg* during their last moments in the air.

Good as the text is, the pictures are what will capture and hold the reader's attention. In a series of paintings prepared for this volume, artist Ken Marschall returns one airship after another to the sky. Hundreds of historic photographs fill the pages. Even the most dedicated and knowledgeable airship buffs can count on finding at least a few images with which they are unfamiliar.

The illustrations include historic paintings, posters, tickets, timetables, philatelic items, and a variety of objects related to the great airships, from the china service of the *Graf Zeppelin* to a scorched pocket watch, its hands frozen at 2:09 a.m., recovered from the wreck of the R-101. Maps, cutaway drawings, and other graphics help bring the text to life. It will be an unimaginative reader indeed who, after studying the detailed fold-out drawings, cannot visualize walking the A and B decks of the *Hindenburg*.

"My system is the best," Graf Ferdinand von Zeppelin once remarked. "If airships are possible at all, then mine are possible." *Hindenburg: Reliving the Era of the Great Airships* is testimony to that fact. This is a book for all of us who long for the days when giants roamed the skies.

—Tom Crouch is chairman of the National Air and Space Museum's aeronautics department and author of Eagle Aloft *(Smithsonian Institution Press, 1983).*

CURATOR'S CHOICE

"We're Go for Launch to Zero-G." *BeeJay Productions (Clark's Video Group, Inc., 1206 N. 8th St., Rogers, AR 72756; 1-800-843-3629). 60 minutes, VHS, $19.95.*

Skylab astronaut Bill Pogue offers a keen sense of what it's like to live and work in space in this new video, which includes lively footage from Apollo, Skylab, and shuttle missions. It's a fascinating journey that would-be astronauts can't help but enjoy.

—Valerie Neal is a curator in the space history department of the National Air and Space Museum.

CREDITS

Cleared for Landing. Bill Burcham is chief of the propulsion and performance branch at NASA's Dryden Flight Research Center in Edwards, California, where he's worked for 30 years.

If They Could See Me Now. When Stephan Wilkinson is not aloft in his Falco, he's often road-testing fast cars for a variety of magazines, including *Condé Nast Traveler* and *Worth*.

Lords of Landing. Peter Garrison is a freelance writer and amateur airplane designer. He crossed the Atlantic and the Pacific in his two-seat homebuilt *Melmoth* and is now building a four-seater to accommodate his two children, who have no interest in aviation at all.

Chad Slattery took his first airplane picture at age 12, when he used his new Brownie camera to photograph a MiG-17 model so that it appeared to be flying over San Diego. Based in Los Angeles, he has specialized in the aerospace industry for the last seven years.

Graphic Supplement. Well-traveled illustrator John Batchelor specializes in military technology, and over the last 30 years he has produced thousands of color artworks, line drawings, and cutaways.

The supplement was made possible by the assistance of Patricia E. Neal, senior chief journalist, U.S. Navy, COMNAVAIRPAC; Commander Chuck Sammons, U.S. Navy (ret.), Association of Naval Aviation; and Peter Mersky.

Mr. Goldin Goes to Washington. Theresa M. Foley, the former editor of *Space News*, has been covering the space program and aerospace industry for 15 years.

The Mosquito Coast. Tom Huntington is the managing editor of *Air & Space/Smithsonian*.

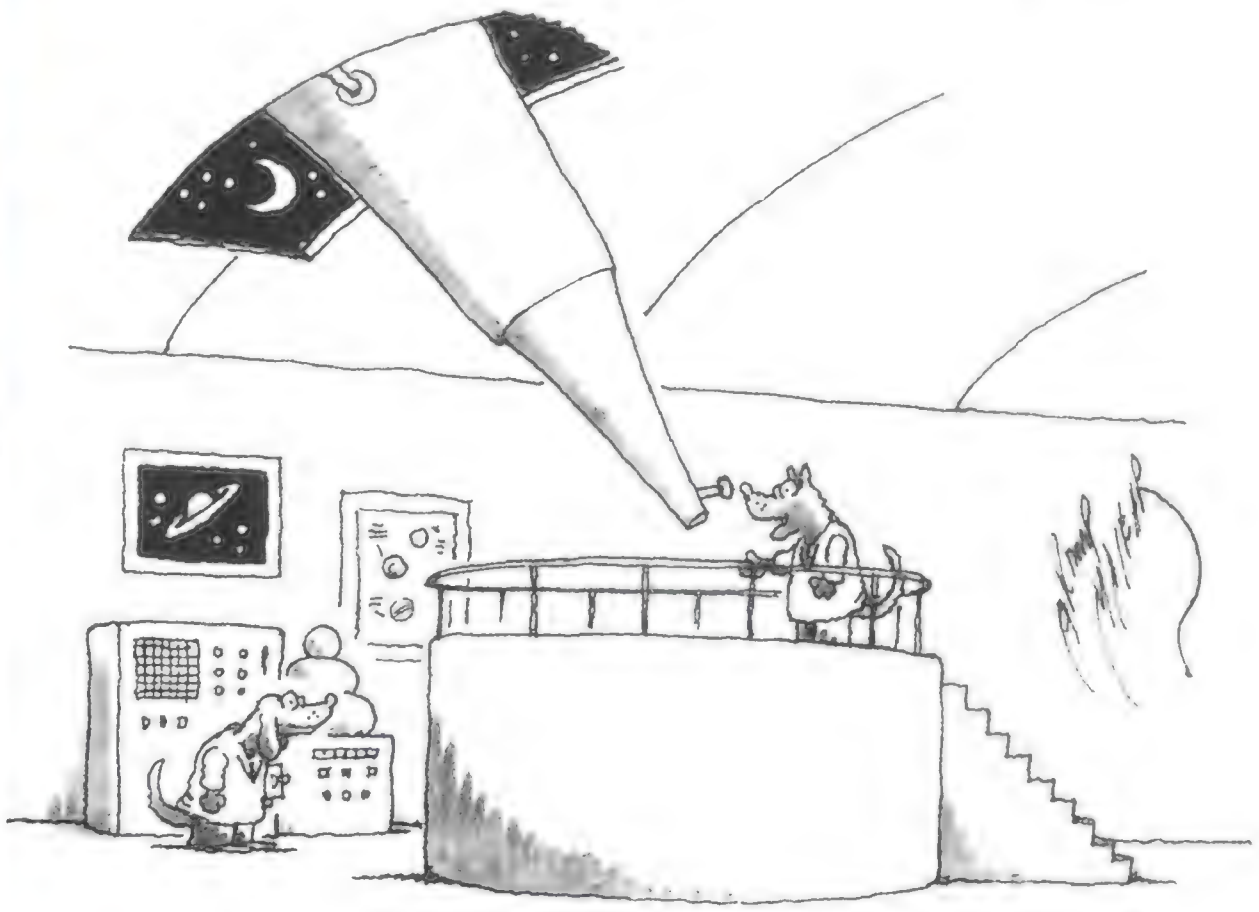
Pilot and photographer Cameron Davidson has published three books of photographs. He became interested in aviation at age seven when his mother went to work as a helicopter-borne reporter.

The Magnetic North. Laurence Gonzales is the author of *One Zero Charlie: Adventures in Grass Roots Aviation* (Simon & Schuster, 1992). A collection of his essays, *The Hero's Apprentice*, was published last year by the University of Arkansas Press.

After attending the Art Center College of Design in the late 1960s, Clark James Mishler set out for Alaska, where he fell in love with the land and its people. Since 1979 he has lived in Alaska and photographed the state extensively.

The Original Space Cadet. Frank Kuznik is a frequent contributor to *Air & Space/Smithsonian*.

Towers of Power. Frequent contributor Richard Sassaman lives in Bar Harbor, Maine. If he had a hot line phone, he would call out for pizza.



"Come quick, Patches! I see Pluto!"

CALENDAR

April 1 & 2
Airshow Orlando. Blue Angels, Sean D. Tucker, Don Johnson, Gene Soucy, wingwalking with Teresa Stokes, and the Super Shockwave Jet Truck. Central Florida Regional Airport, Sanford, FL, (407) 846-4222.

Thomaston-Upson County Airport Fly-In. Thomaston, GA, (706) 647-4500.

April 4–7
National Space Symposium. Sponsored by the United States Space Foundation. Broadmoor Hotel, Colorado Springs, CO, (719) 576-8000.

April 22 & 23
Spirit of Flight Airshow. Lone Star Flight Museum, Galveston, TX, (409) 762-3930.

April 28 & 29
"Focus on Aviation" career seminar. Wilmington College, New Castle, DE, (302) 328-9401.

April 29 & 30
Kitefest. River Oaks Park, Kalamazoo County, MI, (616) 383-8778.

May 5–7
VE Day 50th Anniversary Celebration and Homecoming. Liberty Memorial, Kansas City, MO, (816) 926-6936.

May 13
Northeast Texas EAA Chapter 834 Fly Market. Franklin County Airport, Mt. Vernon, TX, (903) 572-9300.

Prairie Aviation Museum Fly-In Breakfast. Bloomington Airport, IL, (309) 663-7632.

May 21
EAA Chapter 15 Pancake Breakfast. Lewis University Airport, Romeoville, IL, (312) 735-1353.

May 24–29
P-47 Thunderbolt Pilots Association Reunion. Excelsior Hotel, Little Rock, AR, (609) 882-8902.

May 25–27
25th Silver Competition Fly-In. Sponsored by NAI, Black Wings in Aviation. Tuskegee, AL, (800) 777-3799.

May 25–28
368th Fighter Group Reunion. Doubletree Hotel, Crystal City, VA, (404) 455-8555.

May 26–28
West Coast Antique Fly-In and Airshow. Watsonville Airport, CA, (408) 496-9559.

"The Satellite Sky" Update/47

These regular updates to "The Satellite Sky" chart will enable readers to keep their charts up to date. Additions can be clipped and affixed to the chart at the appropriate altitude.

New launches

90 to 300 MILES

- Cosmos 2305 12-29-94 TT

300 to 630 MILES

- Cosmos 2298 12-20-94 PL
- NOAA 14 12-30-94 VAFB
- Tsikada 1-24-95 PL
- Faisat 1-24-95 PL
- Astrid 1-24-95 PL

630 to 1,250 MILES

- Cosmos 2299-23 12-26-94 PL
- RS 15 12-26-94 TT

21,750 to 22,370 MILES

- PRC 41 11-29-94 XI
- Luch 1 12-16-94 TT
- ADSP 4 12-22-94 KSC
- Raduga 32 12-28-94 TT
- Intelsat 7 F4 1-10-95 CAC
- UHF/FO 1-29-95 CAC

Deletions

90 to 300 MILES

Cosmos 2238 down 12-9-94

Cosmos 2267 down 12-28-94

Inoperative but still in orbit

300 to 630 MILES

Cosmos 2150

630 to 1,250 MILES

Cosmos 2245-50

21,750 to 22,370 MILES

ASC-1

DATA: SAUNDERS KRAMER

Launched but not in orbit

90 to 300 MILES

STS-63 U.S. research	2-3-95	down 2-11-95

FORECAST

In the Wings...

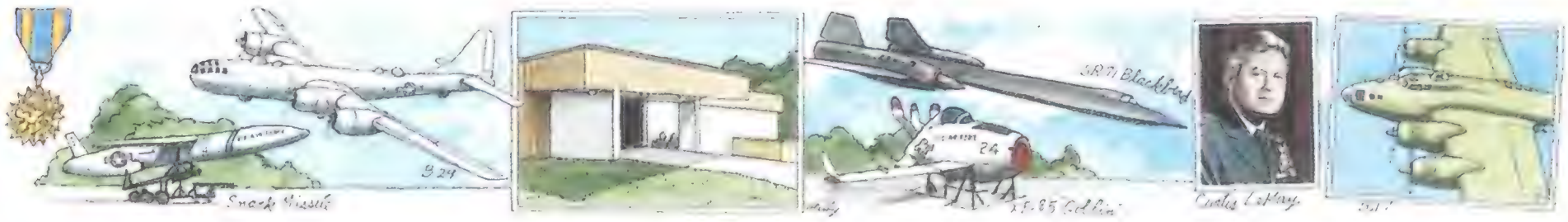
Curtain Call for the Eagles. For 24 years they flew as a team—three talented pilots, combining their individual aerobatic skills in a single precise performance. After this season, the Eagles will return to flying solo.

The Making of Apollo 13. The mission that NASA tried to forget, the one that nearly killed three astronauts on their way to the moon, is now a major motion picture.

Still a Drag. For aerodynamicists, there's only one step left in drag reduction: boundary layer control. The layer of air only thousandths of an inch thick next to the airplane's skin holds secrets to more efficient flight that could save airlines billions of dollars.

Jets on Trucks. Cold war logic: Since airfields are easy targets and the aircraft near them sitting ducks, keep your assets mobile and hidden by launching airplanes from the backs of flatbed trucks. Don't laugh. It worked.

Flying with the Former Enemy. Fighter Wing 73, stationed in Laage, Germany, flies both MiG-29s and Tornados. Until a few years ago, half of the pilots in the wing trained in those same MiGs to shoot down the other half.



JOHN HEINLY

Towers of Power

It's a toss-up as to which Omaha-area motto is better known around the world: Boys Town's "He ain't heavy, he's my brother" or the Strategic Air Command's "Peace is our profession."

Or more precisely, peace *was* their profession. SAC, formed in 1946 as the Air Force command responsible for America's bombers and missiles, was replaced in 1992 by the U.S. Strategic Command, which oversees both Air Force and Navy power. SAC's glory days live on, however, in the Strategic Air Command Museum.

Though privately operated, the museum is located adjacent to the old SAC headquarters at Offutt Air Force Base, just south of Omaha, Nebraska. The site enables the museum to display some artifacts outside, on the runway where the *Enola Gay*, the B-29 that would later bomb Hiroshima, first flew off to war. Back here visitors can see examples of SAC's killer Bs—17, 25, 26, 29, 36, 47, 52, 57, and 58. An FB-111 "Aardvark," a medium-range bomber built in the late 1960s, is exhibited inside the museum building, as is a trainer replica of a B-52D cockpit that visitors can climb into.

SAC's strategic mandate—the use of air weaponry to knock out an enemy's military and economic power centers—required other kinds of aircraft as well. The museum displays an EC-135 Looking Glass and a scale model of an E-4B, which were meant to function as flying command posts in the event that ground-based SAC command centers were lost. There's also an example of the aircraft many consider SAC's superstar—the SR-71 Blackbird, a reconnaissance plane that served until 1990 and once reached a record speed of 2,242 mph.

The Blackbird was one of the aircraft included in the museum's most recent "Crawl Thru," an event held every May that allows visitors to climb inside some of the aircraft. Last year's Crawl also featured a B-17, a B-36, a C-47 transport, a T-39 Sabreliner trainer/utility aircraft, and a Soviet MiG-21 fighter.

The lethal cargo that SAC aircraft carried are shown in an exhibit entitled "Bombs Away," which includes 750-pound "leaflet," 1,000-pound "semi-armor piercing," and 2,000-pound "general purpose" bombs, as well as an Mk 36 thermonuclear model weighing 17,500 pounds loaded and having a yield in the megaton range. Famous bombing missions are commemorated as well. The 1972 bombing of Haiphong and Hanoi, nicknamed "Linebacker II," is represented by a wall of maps and photographs, as well as POW clothing, while a display case holds a bombsight used on Jimmy Doolittle's 1942 raid of Tokyo. To paraphrase Mark Twain, it looks like a protractor with a college education. Also shown is the more complex "gyroscopically stabilized optical aiming and calculating mechanism" known to students of World War II as the Norden M-9B bombsight.

Strategic Air Command Museum, 2510 SAC Place, Bellevue, NE 68005. Phone (402) 292-2001. Open daily 8 a.m.–5 p.m. (to 8 p.m. between Memorial Day and Labor Day), except New Year's Day, Thanksgiving, and Christmas. Admission: $4; veterans and senior citizens, $3.50; children 6–12, $2.

The other form of SAC weaponry—missiles—is most dramatically exemplified by what looks like an 82-foot metal tower standing by the fence along Lincoln Road. No, it's not a Midwestern grain elevator but rather the United States' first operational intercontinental ballistic missile: the Atlas. Surrounding it is a Thor intermediate-range ballistic missile; a Snark intercontinental cruise missile, briefly operational in 1961; a Titan I ICBM, which became operational the following year; and a Blue Scout, a rocket that once launched an unmanned Mercury flight.

The architects of all this air power are commemorated in glass cases in the museum entrance hall, where memorabilia from the 13 SAC commanders-in-chief are displayed. Included is a four-star red hard hat worn by the third commander, General Thomas Power, during ICBM test launches in the late 1950s. Curtis LeMay, the second and best known SAC c-in-c (1948 to 1957), is remembered with a special exhibit room on the main floor containing photos, uniforms, and such personal effects as canteen and marching compass.

The museum also honors the men who actually controlled the missiles, serving anonymously in underground command posts. Visitors can see a section of the post's historic instrument console, complete with yellow, blue, and gray telephones, each dedicated to a different communication link. The console also includes the original red "Hot Line" telephone, set up to transmit a presidential order that would launch missiles at the Soviet Union (it looks kind of like a Princess Phone). "A couple of times a day they'd pick it up and give her a test," recounted Offutt's Lieutenant Colonel Raymond Ruetsch as he took his parents around the museum last summer.

Ruetsch's father, a B-24 ball turret gunner during World War II, had stopped by on his way home from a reunion of his bomber squadron; he was one of many veterans visiting that day. But in coming years, fewer visitors will be able to claim a familiarity with the museum's artifacts. Both the United States and the former Soviet Union are now carrying out the terms of the Strategic Arms Reduction Treaty, which mandates the destruction of much of the world's stock of heavy bombers and missiles.

Still, SAC's history continues to command attention, and will perhaps command even more as the years pass. "As a private organization [the museum] has no classified gear, documents, or any access to such material," says museum executive director Jim Bert. "But over time, with the process of declassification, we will have many more stories to tell here."

—Richard Sassaman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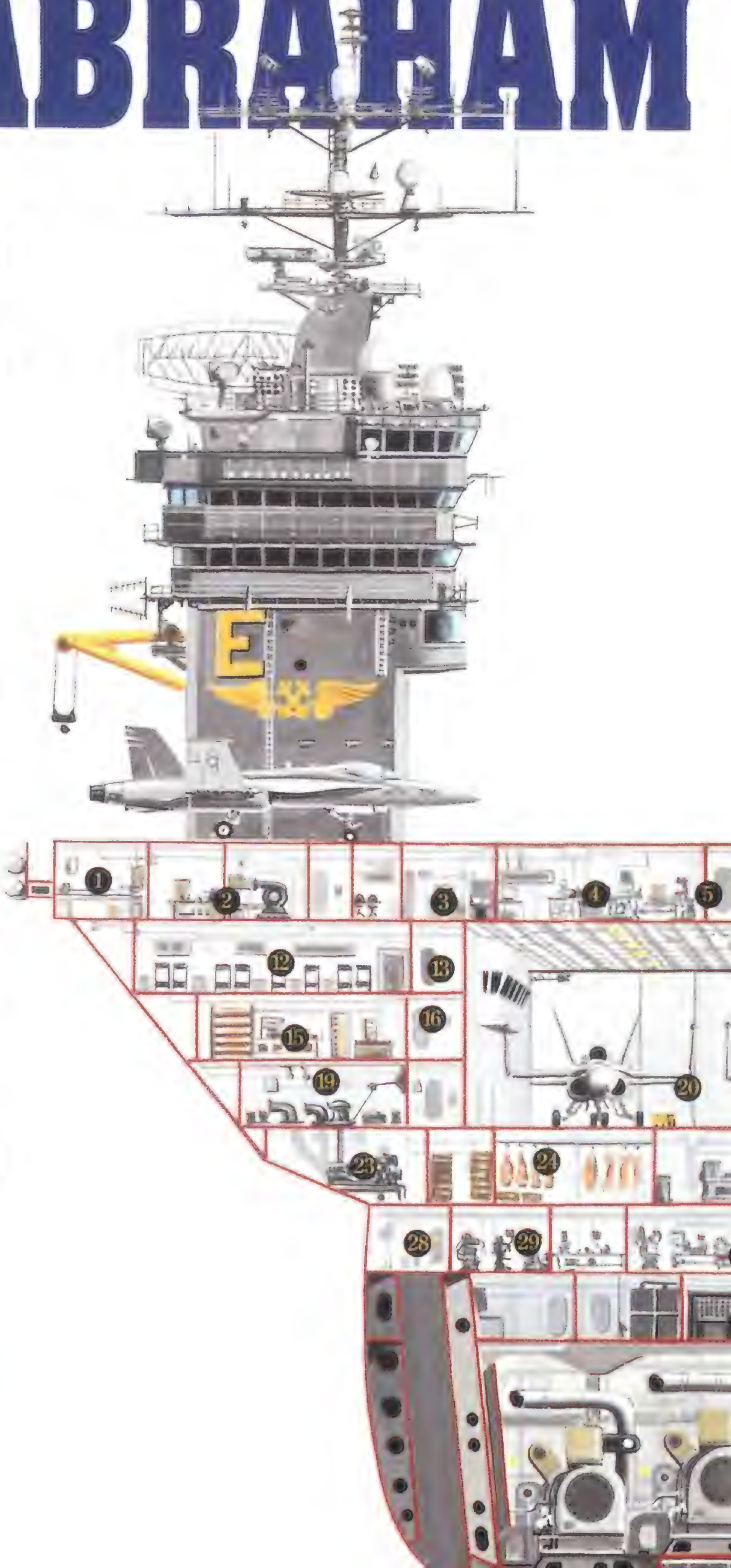
U.S.S. ABRAHAM

The USS *Abraham Lincoln* (CVN-72), one of 12 aircraft carriers serving the U.S. Navy, was commissioned in November 1989 and is based in Alameda, California. A *Nimitz*-class supercarrier, it is powered by two Westinghouse nuclear reactors that drive four steam turbines and propellers, moving the 100,000-ton ship at speeds of more than 35 mph.

The *Lincoln*'s construction cost was $3.1 billion. The carrier's length is 1,092 feet; extreme breadth, 257 feet. With the air wing on board, the *Lincoln* carries some 5,500 people and more than 80 aircraft on its 4.5-acre flight deck and the hangar deck below.



AIR&SPACE
Smithsonian

A supplement to the April/May 1995 issue of *Air & Space/Smithsonian*

LINCOLN

Gallery deck

1. squadron work center
2. fan room
3. electronic and electrical repair
4. electrical test equipment shop
5. weapons elevator machinery room
6. air operations office
7. carrier air traffic control center
8. cabins
9. squadron office
10. catapult piping spaces
11. #4 catapult launching valves

02 level

12. crew living space
13. storeroom
14. catapult steam machinery

01 level

15. TV studio
16. public affairs office
17. air filter cleaning shop
18. auxiliary fuel tank stowage

Main deck

19. aviation fueling at-sea bay
20. hangar
21. catapult piping
22. weapons storeroom

Second deck

23. capstan machinery room
24. thaw room
25. bakery
26. switchboard
27. vent space

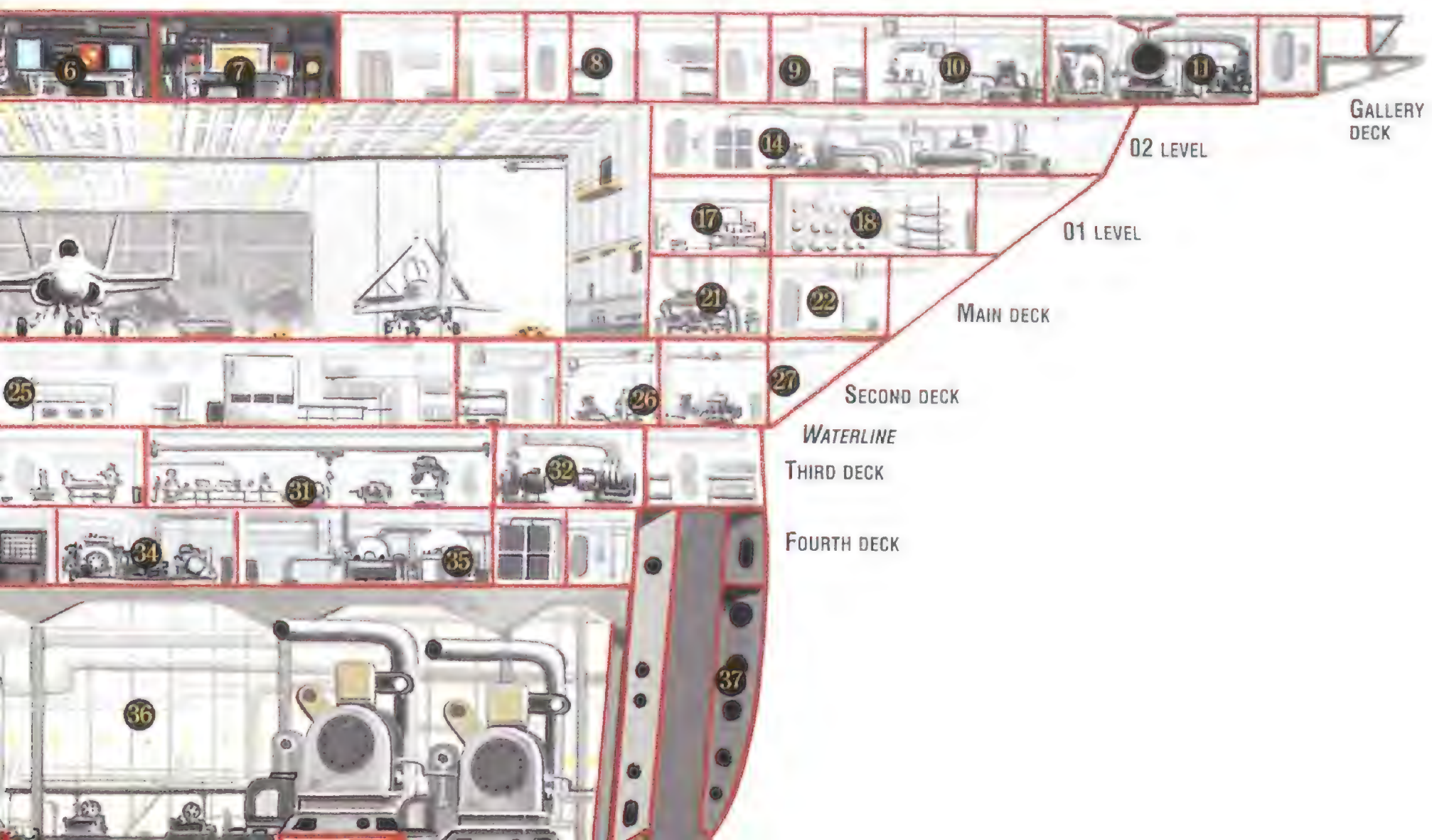
Third deck

28. welding and repair
29. combustion control shop
30. metalsmith and machine shop
31. electrical shop
32. fan room

Fourth deck

33. switchboard room
34. gyro room
35. main machinery room
36. engine room
37. ballast

Cutaway is a composite of two sections; island moved slightly for perspective.



A carrier air wing, which consists of some 80 aircraft and 2,000 officers and enlisted men, is assigned to each aircraft carrier. Squadron assignments to air wings change, and an entire wing can transfer to another carrier. In 1995, the *Lincoln* carries CVW 11, which comprises the following squadron
Fighting Aardvarks) and VF-213 (F
(F/A-18, Fighting Redcocks) and V
strike fighters, VMFA 314 (F/A-18)

F/A-18 Hornet: Twin-engine McDonnell Douglas strike fighter. Mach 1.7-plus. Wingspan 37.5 feet. Maximum takeoff weight 51,900 pounds.

F-14 Tomcat: Twin-engine Grumman air superiority fighter with variable-sweep wing. Mach 2-plus. Wingspan 38 feet swept, 64 feet unswept. Maximum takeoff weight 69,800 pounds.

SH-60 Seahawk: Twin-engine Sikorsky anti-submarine helicopter. 150 mph. Rotor diameter 53.7 feet. Weight 20,508 pounds.

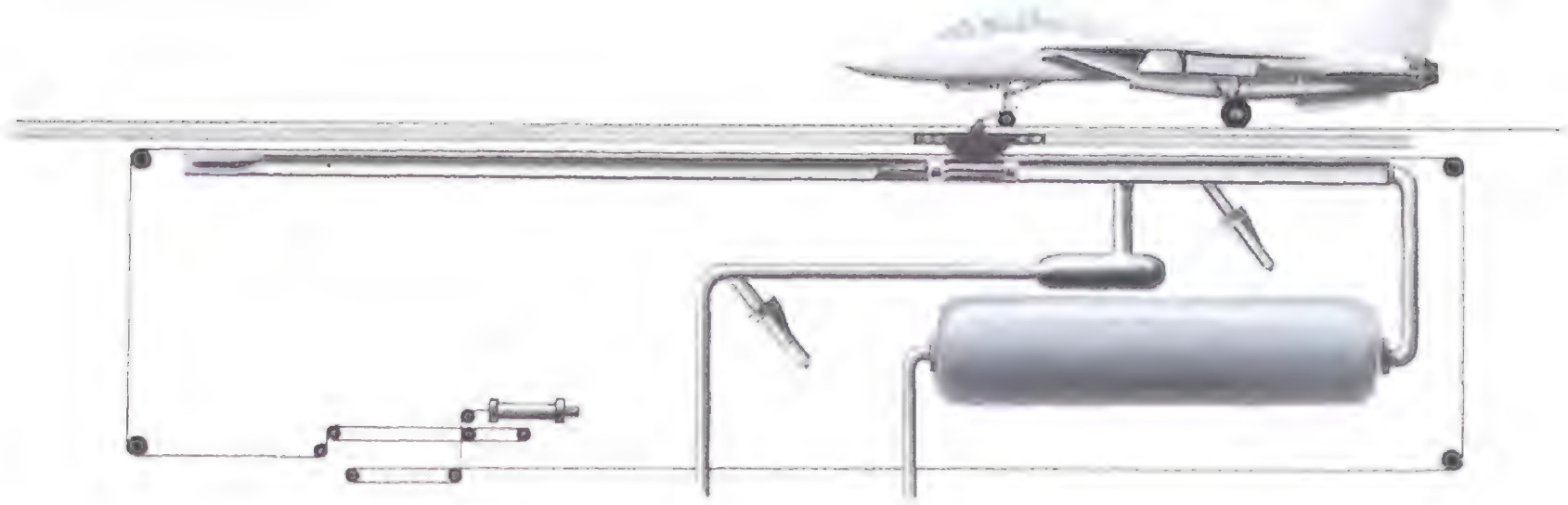
s: VF-114 (F-14, World Famous
-14, Black Lions) fighters, VFA-22
FA-94 (F/A-18, Mighty Shrikes)
Marine strike fighters, VA-95 (A-6E,
Green Lizards) medium attack, VAQ-135 (EA-6B, Black Ravens) electronic countermeasures, VAW-117 (E-2C, Wall Bangers) early warning, VS-29 (S-3B, Vikings) fixed-wing antisubmarine, and HS-6 (SH-60, Indians) helicopter antisubmarine.

E-2C Hawkeye: Twin-turboprop Grumman airborne warning and control system platform. 368 mph. Wingspan 80.5 feet. Maximum takeoff weight 53,000 pounds.

A-6E Intruder: Twin-engine Grumman all-weather attack aircraft. 647 mph. Wingspan 53 feet. Maximum takeoff weight 58,600 pounds.

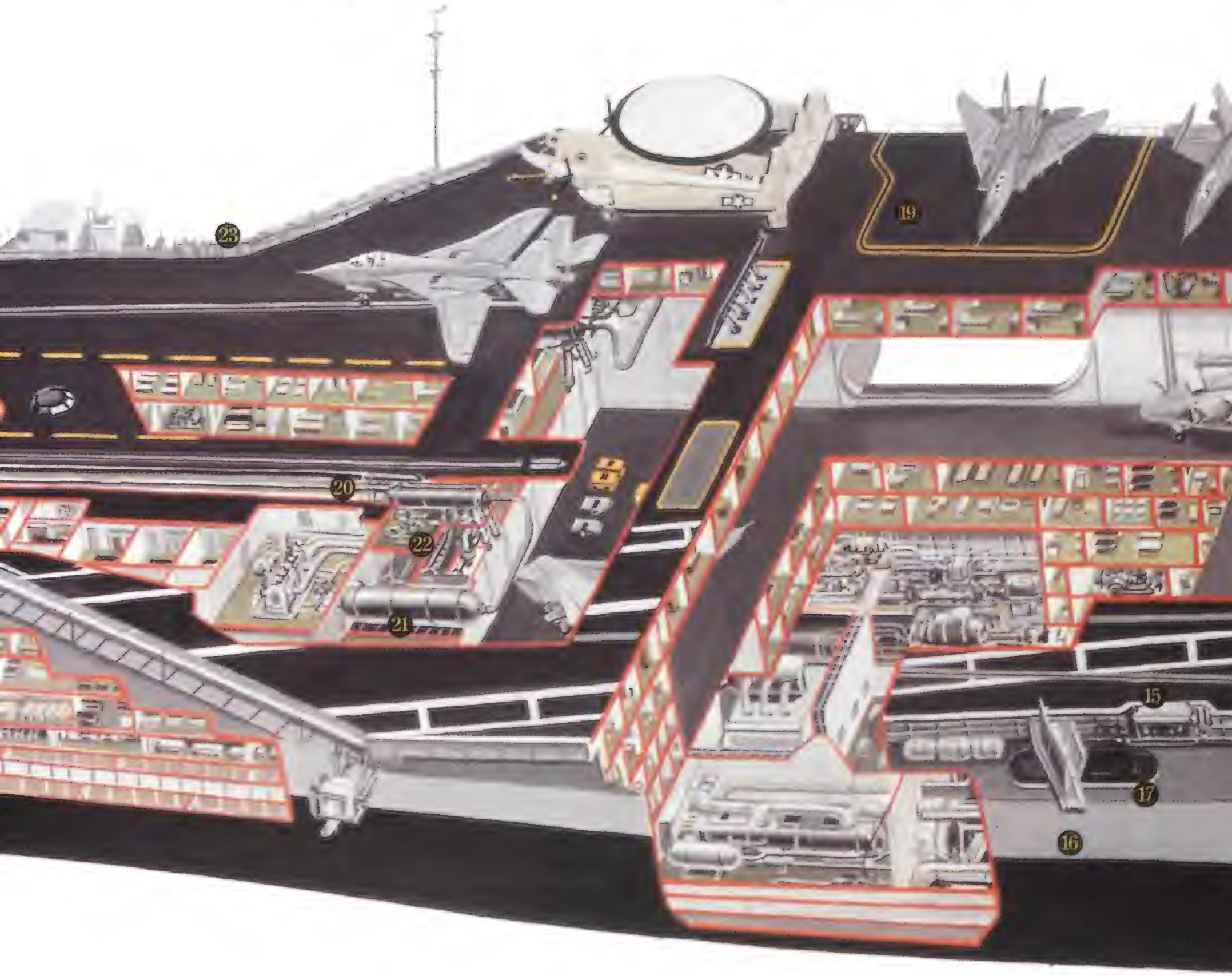
S-3B Viking: Twin-turbofan Lockheed submarine hunter. 517 mph. Wingspan 68.7 feet. Maximum takeoff weight 52,539 pounds.

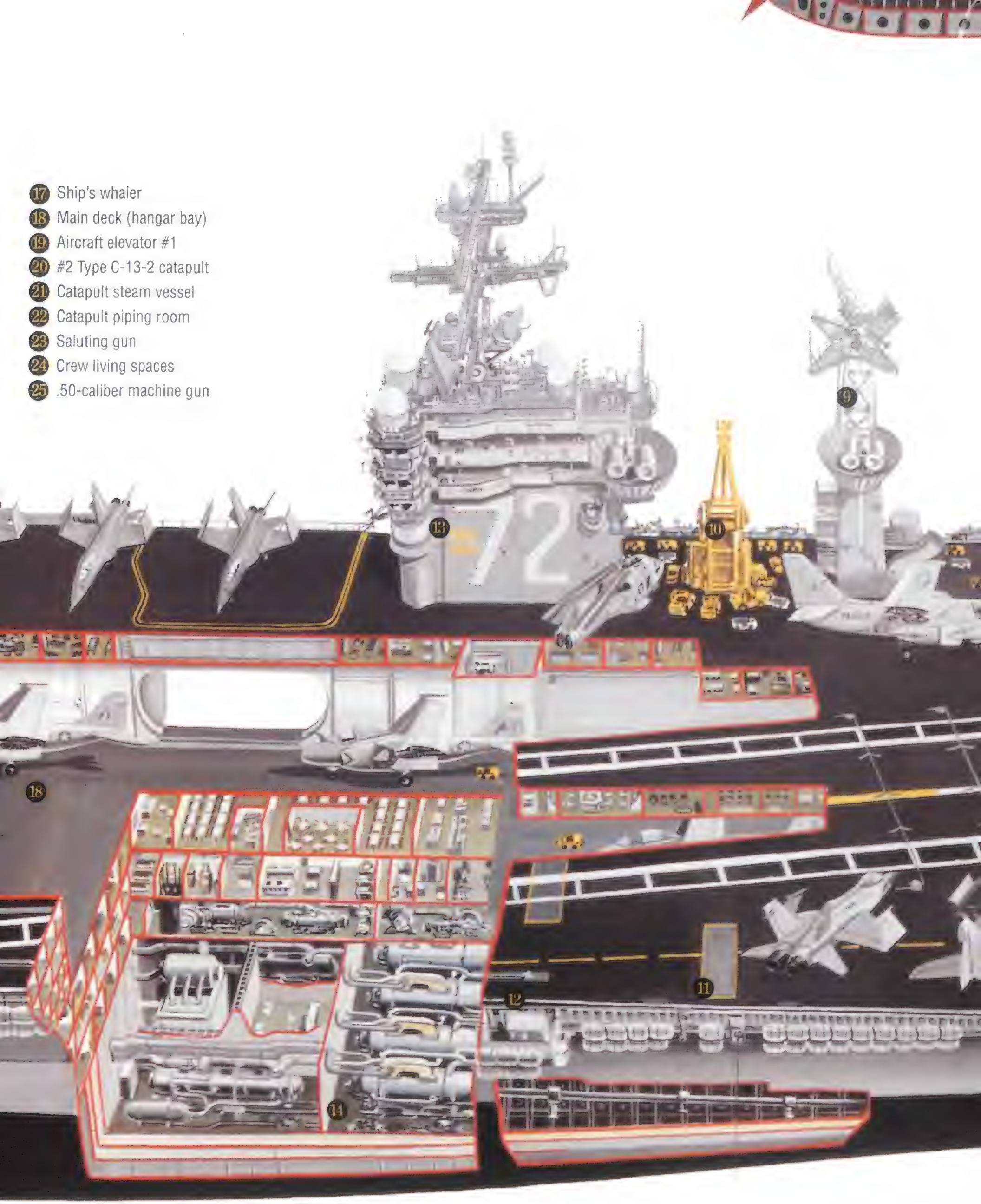
EA-6B Prowler: Twin-engine Grumman electronic warfare aircraft. 622 mph. An EW version of the A-6E Intruder.



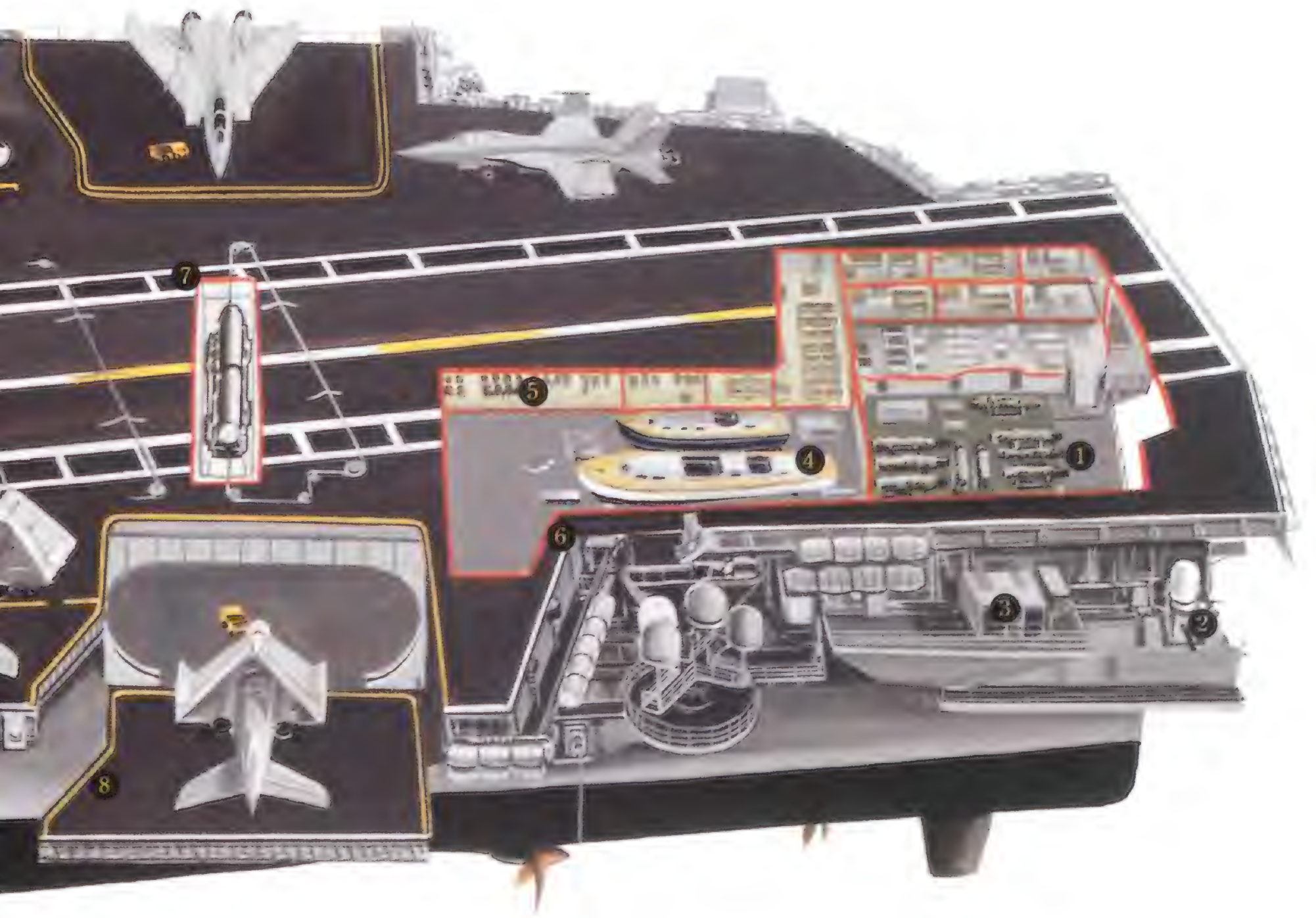
The catapult consists of two rows of slotted cylindrical piping in a trough beneath the flight deck. A bar on the nosegear of an aircraft attaches to a shuttle that protrudes above the deck and is connected to a pair of pistons in the trough. A holdback device is installed on the nosegear to hold the aircraft in place as tension is applied. On a signal from the catapult safety observer on the flight deck, the catapult is fired, which opens the launching-valves assembly (the length of time the valves remain open is determined by the weight of the aircraft and the wind over the deck). Steam surges into the cylinders, snapping the holdback in two and forcing the pistons, shuttle, and aircraft forward at an increasing speed. A 60,000-pound aircraft is accelerated up to 150 mph in two seconds and 309 feet. The shuttle is stopped when spears on the pistons plunge into water brake cylinders. A cable and pulley assembly then pulls the shuttle back down the catapult for the next launch. From its four catapults, the *Lincoln* can launch an aircraft every 20 seconds.

1. Aviation jet engine shop
2. Phalanx 20 mm close-in weapons system
3. NATO Sea Sparrow Mk 29 launcher
4. Ship's boats
5. Squadron ready rooms
6. Landing signal officer platform
7. #1 Mk 7 Mod 3 arrester gear engine
8. #4 aircraft elevator
9. Air search radar
10. Mobile crane
11. Jet blast deflector, #4 catapult
12. Missile arming/de-arming platform
13. Island: Primary flight control/air boss, navigation bridge, admiral's bridge, radar and electronics, chart room, flight deck control, flight deck TV camera
14. Main engine room (arrangement notional)
15. Catapult officer launch control station (#3, #4)
16. Optical landing system (ball)




17 Ship's whaler
18 Main deck (hangar bay)
19 Aircraft elevator #1
20 #2 Type C-13-2 catapult
21 Catapult steam vessel
22 Catapult piping room
23 Saluting gun
24 Crew living spaces
25 .50-caliber machine gun
9
10
11
12
13
14
18
72

Four 1.375-inch-thick steel cables run 5.5 inches above the deck at 35-foot intervals and connect with a hydraulic cylinder below the deck—basically a giant shock absorber. As an aircraft approaches, all four wires are set to accommodate that aircraft's weight. When the aircraft's arresting hook snags a wire, the wire pulls a piston within a fluid-filled cylinder. As the piston is drawn down the cylinder, hydraulic fluid is forced through small holes in the cylinder wall, thus absorbing the energy of the aircraft and braking it to a stop. An arresting wire can stop a 54,000-pound aircraft traveling over 130 mph in two seconds and some 340 feet. When the aircraft drops the wire, the piston is retracted and ready to recover another aircraft in 45 seconds.



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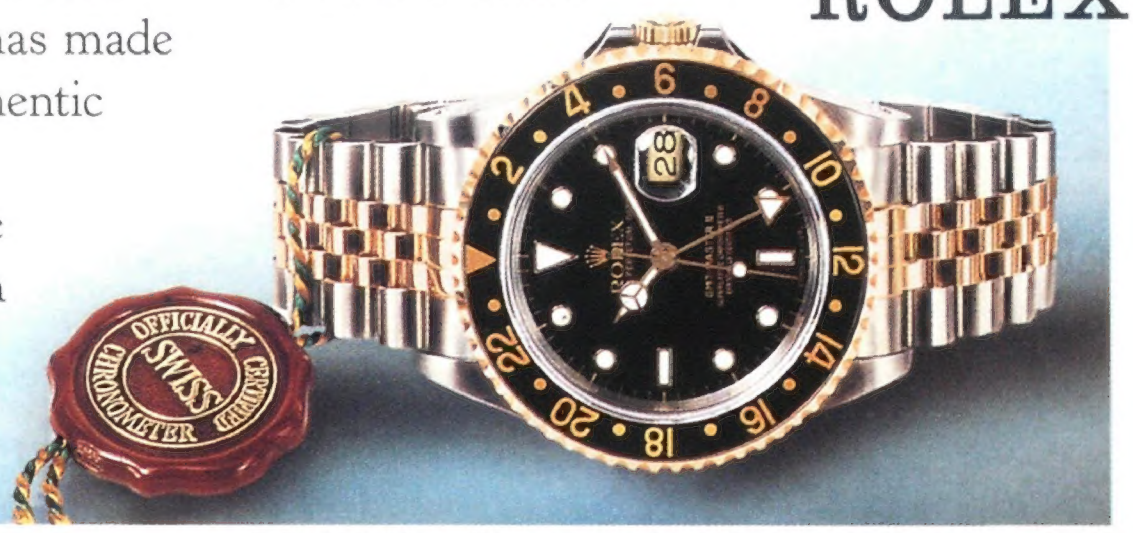
"If you want to grow old as a pilot, you've got to know when to push it, and when to back off." *Chuck Yeager*

Throughout his remarkable career, Chuck Yeager has shown an uncanny talent for what pilots call "pushing the edge of the envelope." At 21, only three years after boarding his first plane, Yeager was leading a squadron of fighter pilots in World War II. And at the age of 24, he became the first person to fly faster than the speed of sound.

Attempting such dangerous feats is one thing. Living to describe them to your grandchildren is another. Displaying the enormous courage, skill and cool judgment needed to do both has made General Chuck Yeager an authentic American hero.

Although retired from the military, Yeager remains a man on the move. He's an avid sportsman with a lifelong love of the outdoors, a lecturer and a consulting test pilot who still loves to fly. "Maybe I don't jump off 15-foot fences anymore," says Yeager, "but I can still pull 8 or 9 G's in a high-performance aircraft." And in all his exploits, Yeager depends on a rugged and reliable timepiece. "I wore a Rolex more than 40 years ago when I broke the sound barrier and I still do today," says Yeager matter-of-factly. "A pilot has to believe in his equipment. That's why I wear a Rolex."

ROLEX



Rolex GMT-Master II in stainless steel and 18kt gold with matching Jubilee bracelet.
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